HEWLETT
PACKARD

43110MC DEFIBRILLATOR/ MONITOR-RECORDER

assigned # by the ARMY
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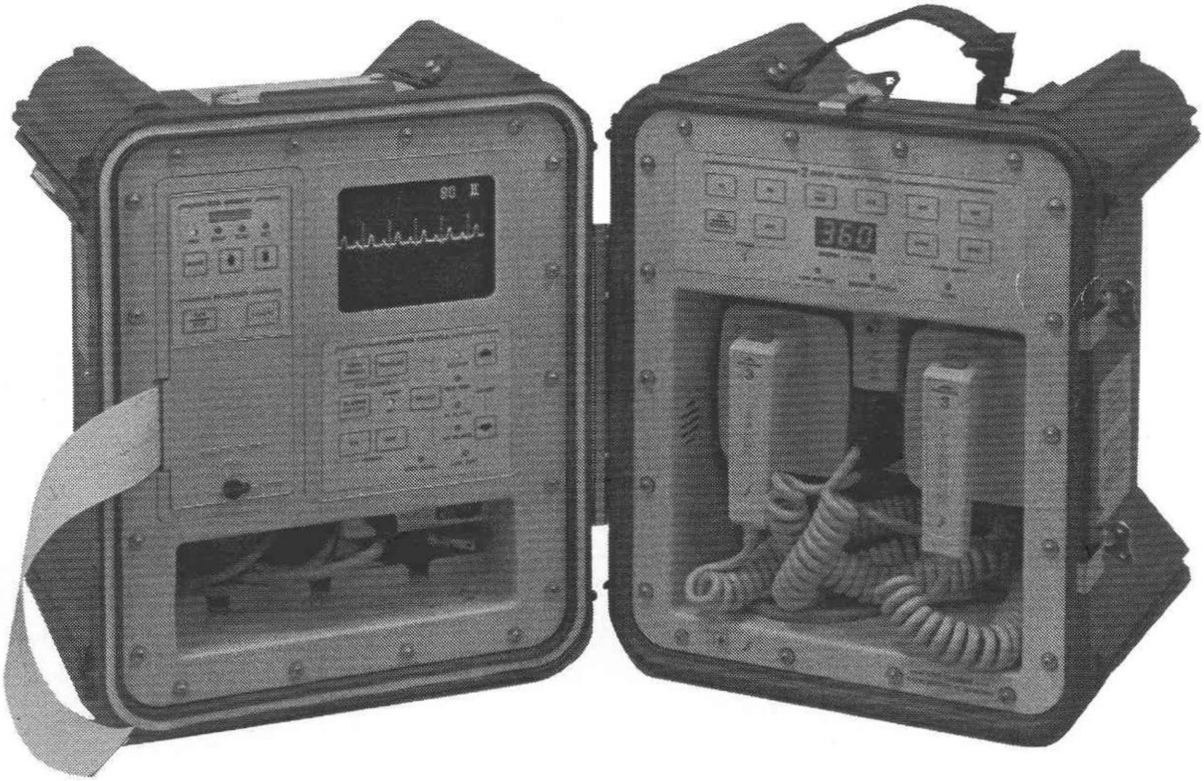

OPERATING GUIDE

HEWLETT
PACKARD

43110MC
DEFIBRILLATOR/MONITOR-RECORDER

OPERATING GUIDE

PART NUMBER 43201-91908

DO:	Read the OPERATING GUIDE before operating the instrument
	Exercise CAUTION when using the instrument
	Keep a battery installed in the instrument at all times
	Keep the battery charging during standby periods
DON'T:	Open the instrument case
	Use the defibrillator in flammable atmosphere
	Allow excess electrolyte past or gel to accumulate
	Allow the battery to discharge to low levels repeatedly

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McMINNVILLE DIVISION
1700 South Baker Street
McMinnville, Oregon 97128

REV E0390-1

March 1990

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If HP receives notices of such defects during the warranty period, HP shall at its option either repair or replace hardware products which prove to be defective.

PLACE OF PERFORMANCE

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Hewlett-Packard Company, McMinnville Division
1700 S. Baker St.
McMinnville, Oregon 97128

Attention DEPMEDS Warranty Services, Return Authorization #30001484

All warranty repairs will be performed by HP or by a subcontractor authorized by HP to act in its behalf.

Repaired hardware will be shipped, freight prepaid, to the specified CONUS location.

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The foregoing warranty shall not apply to defects resulting from:

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- Unauthorized modification or misuse, or
- Operation outside of the environmental specification for the product.

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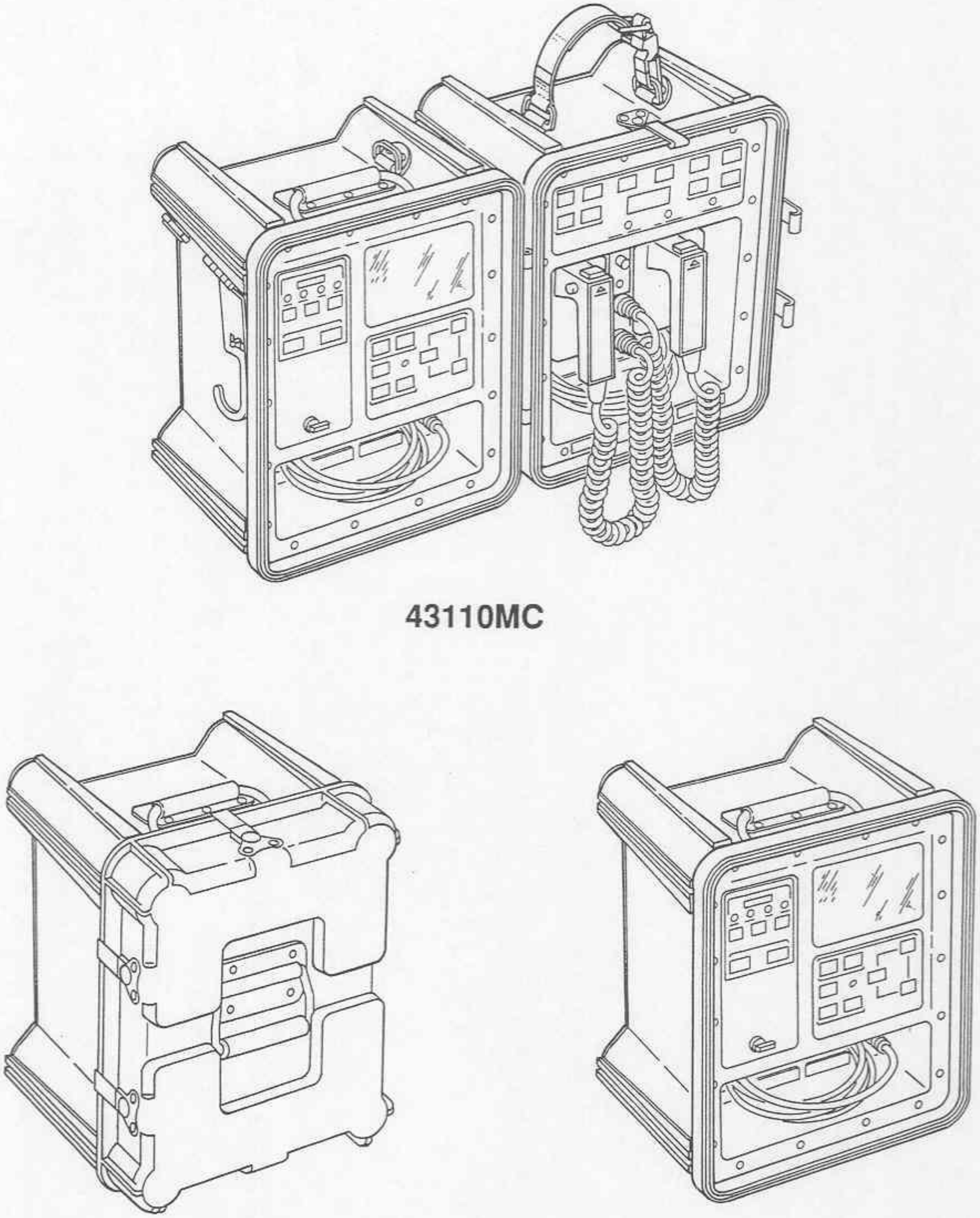
1 GENERAL INFORMATION



43110MC

43200MC

43200M

Figure 1: Equipment Configurations

INTRODUCTION

This Operating Guide provides operation and basic maintenance instructions for the safe use and proper care of the Hewlett-Packard Model 43110MC Defibrillator/Monitor-Recorder System.

Information is presented in such a manner as to provide operational instruction for the HP 43110MC Defibrillator/Monitor-Recorder System, the HP 43130M Defibrillator, and the HP 43200M/MC/MD Monitor-Recorder.

NOTE

Before using these instruments, read this manual and become thoroughly familiar with its contents.

INSTRUMENT CONFIGURATION

This manual covers three different instrument configurations (figure 1).

- A combination Defibrillator/Monitor-Recorder system, Hewlett-Packard Model 43110MC (NSN 6515-01-291-1199). System consists of one HP 43130M Defibrillator module, one HP 43200MD Monitor-Recorder module, and combining case.
- A separate Monitor-Recorder with cover, Hewlett-Packard Model 43200MC (NSN 6515-01-291-1198).
- A separate Monitor-Recorder without cover, Hewlett-Packard Model 43200M (NSN 6515-01-291-7048).

SAFETY CONSIDERATIONS

The Defibrillator module stores high voltage energy and is capable of delivering up to 360 Joules of DC energy to a 50Ω impedance. Disconnecting the Defibrillator module from an AC outlet will not remove power; the instrument is battery-powered, meaning that the power switch must also be placed in the OFF/RECHARGE position. In order to disarm a charged unit, press either the POWER ON/DISARM or OFF/RECHARGE keys, or place the paddles in their holders and depress both DISCHARGE buttons. As a safety feature, the Defibrillator module is designed to automatically discharge internally if it has been left charged for more than 60 seconds.

WARNINGS

Avoid open paddle discharges. Dangerous high voltage potentials exists on the paddles when the defibrillator is discharged this way. Accidental contact with this high voltage potential could cause death or serious injury.

Inspect the defibrillator paddle connecting cables frequently for breaks, cuts, or fraying. Never operate the defibrillator if connecting cables are found defective.

SAFETY CONSIDERATIONS — Continued

CAUTION

Do not discharge the defibrillator with the paddles shorted together or damage (burning and pitting) to the metal electrodes may result.

The Defibrillator and Monitor-Recorder handles and controls are designed to minimize shock hazard. When not plugged into an AC line, the system is battery-powered without reference to earth ground, and small static charges may be generated during defibrillator discharges. These static charges present a minor shock potential to the operator, but ONLY through exposed metal surfaces (like the ground connector). Avoid touching these surfaces during defibrillator discharge.

WARNING

Inspect the AC line cord frequently for breaks, cuts, or fraying. Never operate the Defibrillator/Monitor-Recorder using a defective power cord.

Medical electronic equipment which may not incorporate defibrillation protection, e.g., blood flow meters, should be disconnected from the patient during defibrillation discharge.

NEVER touch the bed, the patient, or any equipment connected to the patient (e.g., patient leads) during defibrillation. Fluids such as Ringer's saline solution and blood are excellent electrical conductors; to avoid creating potentially dangerous electrical paths, keep the instrument and the immediate area clean and dry at all times.

NEVER remove the instrument from the case; there are no operator controls inside and dangerous high voltages may be exposed. Refer servicing to qualified service personnel.

ALWAYS press the pressure relief value (on side of monitor case) before attempting to open case halves. Failure to equalize the pressure to present levels before opening may cause case halves to blow apart or not separate when unlatched.

NEVER attempt to lift or move the equipment without the hinges properly attached and the latches fastened. Damage to personnel or equipment may result from improper usage.

DO NOT use the Defibrillator module in a flammable atmosphere (i.e. oxygen tents or other areas of concentrated flammable anesthetics). Avoid using portable or emergency vehicle-mounted defibrillators immediately near the site of an automobile wreck; spilled gasoline and puddles of water present extremely dangerous explosion and shock hazards.

SAFETY CONSIDERATIONS — Continued

Safety includes safeguards against inadvertent harm to the operator, the patient, the service technician, and the environment.

Operator Safety. When the defibrillator is charged to the specified level, a steady tone alerts nearby personnel. In addition, the operator is informed of the charge status by a 3 digit front panel display, and an illuminated charge done LED on the Apex paddle. Handguards around the paddles prevent shock to the operator. If left in a charged state, the Defibrillator module discharges itself safely into an internal load after 60 seconds.

Patient Safety. Shock hazard is minimized by limiting the current that can flow thru the equipment to a patient who is inadvertently attached to ground or line voltage potential.

Service Safety. Shock hazard is minimized by placing warning labels near hazardous, high voltage areas. The service manual contains additional warnings to protect the service technician during repair.

Both the Defibrillator and Monitor-Recorder modules are designed to meet requirements specified in UL544 and AAMI defibrillator standard. The UL544 certified design prevents fires from developing should a component failure occur. The internal storage capacitor **DOES NOT** contain PCBs.

USER CONSIDERATIONS

The conditions surrounding the use of the Defibrillator/Monitor-Recorder are urgent and stressful. Personnel responding to a cardiac arrest must have the capability to rapidly assess the clinical condition of the patient.

The cardiac monitor must be quickly deployed, providing the necessary information to the clinician without time wasted on making or verifying instrument settings.

The defibrillator must be instantly available, capable of being rapidly charged and discharged without requiring the operator to execute a complicated operating sequence.

Stabilized patients who require ECG monitoring and diagnostic ECG recording are treated differently. In these cases, the other features of a cardiac monitor become important. For example

- The operator may wish to manually adjust the size of the ECG waveform for better viewing from a distance
- Heart rate alarms may be required to keep watch over a stable patient.

WARNING—PACEMAKER PATIENTS

Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest or some arythmias. Do not rely entirely upon the rate meter alarms. Keep Pacemaker patients under close surveillance. This instrument does not reject pacemaker pulses.

- A different view of the ECG may be chosen with the lead selector.

These secondary features must be accessible to the operator and easy to use.

USER CONSIDERATIONS — Continued

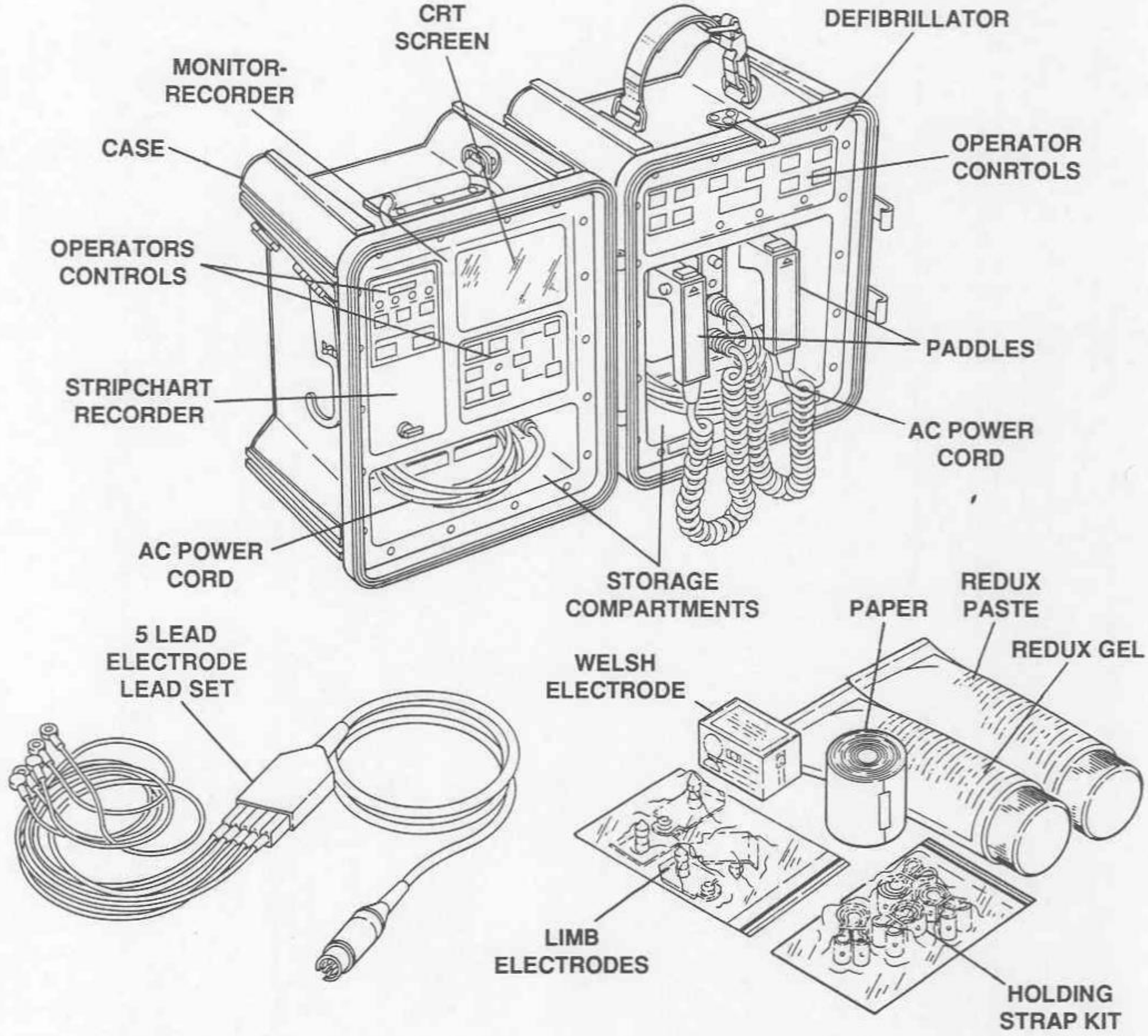

CRT SCREEN
DEFIBRILLATOR
MONITOR-RECORDER
CASE
OPERATOR CONRTOLS
OPERATORS CONTROLS
PADDLES
STRIPCHART RECORDER
AC POWER CORD
AC POWER CORD
STORAGE COMPARTMENTS
REDUX PASTE
PAPER
5 LEAD ELECTRODE LEAD SET
REDUX GEL
WELSH ELECTRODE
LIMB ELECTRODES
HOLDING STRAP KIT

Figure 2. Model 43110MC Defibrillator/Monitor-Recorder

ABOUT THE HP 43110MC DEFIBRILLATOR/MONITOR-RECORDER SYSTEM

The HP 43110MC is a separable modular unit consisting of independently operable Defibrillator and Electrocardiograph/Monitor-Recorder modules. The entire system is portable, with a total weight of 50 pounds occupying 2.7 cubic feet.

ABOUT THE HP 43110MC DEFIBRILLATOR/MONITOR-RECORDER SYSTEM — Continued

On-board storage compartments for supplies and accessories eliminate the need for separate supply kits. This makes it easy to examine the equipment for proper provisions.

- The Monitor-Recorder storage compartment contains the patient cable, one suction and four limb electrodes, two rolls of ECG paper, a tube of Redux gel (P/N 651-1024-050), an ECG ruler, and an AC power cord. A third roll of ECG paper is stored in the recorder, ready for use.
- The Defibrillator storage compartment provides storage for the paddles, paddle cables, Redux paste (P/N 651-1008-050), and AC power cord.

The modules are physically interconnected by a separable hinge and latch mechanisms. Communication between the two modules is accomplished by non-contact infrared optical signals.

NOTE

The optical communication circuit is designed to prevent communication between case halves at distances greater than 3-4 inches. Make sure case halves are mated correctly for proper operation of the optical communication circuit.

Controls are all located on the front panel of both modules for maximum accessibility, and are in the form of large, easily actuated membrane keys. Operating sequences and controls are simple and logical.

The Defibrillator/Monitor-Recorder offers synchronous cardioversion capability when both modules are interconnected. The synchronized cardioversion mode is activated by the SYNC switches on the Defibrillator module control panel. Accidental SYNC mode entry and exit is prevented by requiring both SYNC keys to be pressed simultaneously.

- When the Monitor-Recorder module is properly connected to the Defibrillator module, the SYNC light on the Defibrillator module will come on, and then flash off with each detected systole. The CRT screen will display the message "SYNC" to indicate the synchronous mode of operation. If the patient cable is not being used as the source for the ECG signal, the monitor will display the message "USE LEADS" to remind the operator that the patient cable should be used for synchronization mode to minimize noise and interference. However, the system will allow cardioversion with a paddles-derived signal. A bright dot will occur on the QRS waveform to indicate where the discharge would occur. If the stripchart recorder is on, a short vertical marker line will occur. The marker is placed in the margin of the paper so it does not interfere with the the recording. The Defibrillator module will discharge within 60 msec of a detected R wave when both paddle discharge switches are pressed and held. After discharge, the SYNC mode will be exited, and the unit returned to defibrillation mode. If the unit is charged in the SYNC mode, but not fired, it will automatically discharge internally after 60 seconds.

ABOUT THE HP 43110MC DEFIBRILLATOR/MONITOR-RECORDER SYSTEM — Continued

NOTE

Keep infrared optical windows clear and free from obstruction during operation.

- When the Monitor-Recorder is not connected to the Defibrillator, the SYNC indicator light will flash once and error message "EEE" will briefly appear on the defibrillator's energy display.

The Defibrillator/Monitor-Recorder system operates over a wide range of AC power sources, or from the internal rechargeable batteries. Assembling the modules together to form the Defibrillator/Monitor-Recorder system has no effect on the way each module is powered.

- The Defibrillator and Monitor-Recorder modules each operate directly from AC power when connected. Both modules may be connected to 100-255 V, 47-63 Hz AC power source without modification or changes. The Monitor-Recorder incorporates a digital notch filter in the ECG signal processing software which automatically selects either 50 or 60 Hz to prevent ECG interference. This allows operation on power sources available anywhere in the world.
- Each module is equipped with a 2.9 Ampere-hour sealed lead-acid battery and an AC power supply. While connected to AC power, the internal batteries in each instrument will recharge. When not connected to AC power, the modules are powered from the batteries.
- Low battery indicator lamps are located on the Defibrillator and Monitor-Recorder modules, and a "LOW BATTERY" message is also displayed on the CRT. The low battery indicator will illuminate when there is a minimum of 0.5 hours of monitoring (Monitor-Recorder module) and/or at least 5 full energy discharges remaining (Defibrillator module).

ABOUT THE HP 43200M/MC/MD MONITOR-RECORDER MODULE

The Monitor-Recorder module is a full-featured bedside cardiac monitor designed to offer instant access to vital patient information immediately after turn-on. Advanced design offers full automatic function to speed up rapid emergency use, with manual operator override capability provided. When the power is turned on, the instrument powers up in the paddles mode, with ECG SIZE to AUTO, heart rate alarms set off but preset to 40 and 140 beats per minute (bpm), and the ECG memory on and recording (set to stop 25.5 minutes after an alarm).

The Monitor-Recorder module's intended use is to monitor the ECG of patients in, or in danger of entering, cardiac crisis. It is designed to interconnect physically and functionally with the HP 43130M Defibrillator module for the purpose of performing synchronized cardioversion. A 5-lead cable and a LEAD SELECT key on the Monitor-Recorder module allows recording the complete 12 lead ECG in a standard single channel format.

ABOUT THE HP 43200M/MC/MD MONITOR-RECORDER MODULE — Continued

NOTE

The QRS detectors may inadvertently be triggered by noise, pacemaker pulse, etc. The operator must guard against the potential hazard by correctly positioning the leads and verifying correct heart rate metering.

ECG size, QRS Beeper volume, and High and Low Heart Rate alarm limits are adjustable. 12-lead selection is provided, and a 30-minute ECG memory can be set to stop (at an adjustable time) after an alarm.

A non-fade ECG display is presented on a long-persistence green type 5-inch CRT monitor screen. The ECG display is in a moving (25 mm/second) erase-bar mode , which allows the operator to view 4 seconds of ECG waveform information in a stationary presentation on the screen until it is replaced by new information. The monitor screen is also used to display Heart Rate (15 - 300 beats per minute), ECG source, alarm Limits (when setting or violated), and operator convenience and alert messages.

A diagnostic quality (.05 - 100 Hz) ECG stripchart recorder is also provided. The recorder uses a thermal array print device to record both the ECG waveform and messages on thermally sensitive paper. The thermal array recorder produces a high-quality tracing without a stylus. The traces produced by the thermal array recorder are uniform, rather than varying in breadth with stylus velocity (faint R waves) as do the stylus recorders. Since the thermal array recorder has fewer moving parts, it is more reliable and requires less maintenance than the older stylus-type recorder. There is no operator adjustment required, and no stylus to change.

Paper speed is 25 mm/second (± 5%) and the trace is automatically centered on the paper. The paper also has a red stripe in the margin of the last 3 1/2 feet of the roll. In addition a LOW PAPER and NO PAPER warning message is displayed on the CRT screen indicating paper status.

A 1 mV reference signal can be selected and is used to calibrate the recorder. The signal also appears on the CRT monitor screen.

A 30-minute ECG memory stores ECG waveform information for later review on the monitor screen and/or stripchart recorder. RECORD, STOP, and PLAY, along with fast forward and rewind controls are provided to facilitate playback.

NOTE

When in the ECG memory playback mode, the front panel PLAY indicator will be on, and "PLAY BEGIN", "PLAYBACK", or "PLAY END" will be displayed on the CRT screen to indicate the information displayed is recorded and ***NOT*** *real time.*

ECG memory post-alarm recording time can be specified by the operator. While the information leading up to an alarm is important, most of the attention is focused on more recent information during and following the interventions performed after an alarm. For this reason, the default settings of 4.5 pre-alarm and 25.5 post-alarm minutes have been used.

The Monitor-Recorder module contains its own independent power supply and internal battery. The power supply function is independent of the Defibrillator module (if and when connected).

ABOUT THE HP 43130M DEFIBRILLATOR MODULE

The HP 43130M Defibrillator module is a DC defibrillator featuring a Lown (damped sinusoidal) waveform, simple 1-2-3 operation, and AC or internal battery powered capability. It is designed to interconnect physically and functionally with the HP 43200M Monitor-Recorder module for the purpose of performing synchronized cardioversion and the ability to monitor the ECG using the paddle electrodes.

The defibrillator features simple **1-2-3** operation, as follows:

1. **TURN POWER ON** - Depress the ON switch.
2. **CHARGE** - Depress charge button (either on the APEX paddle or control panel).
3. **DISCHARGE** - Simultaneously depress both discharge buttons (on each paddle).

The Defibrillator module provides six energy settings: 40, 70, 100, 200, 300, and 360 Joules.

NOTE

360J is the maximum energy setting recommended by the American Heart Association.

Energy selection is accomplished by the Energy Select/Charge controls on the Defibrillator module control panel. The controls both select and charge the defibrillator to the specified energy setting. An additional charge button is located on the Apex paddle and charges the unit to the last selected energy level. If a level has not been selected since turn-on, the unit will charge to 200 J (AHA recommended first shock energy).

The Defibrillator module provides several indications of the state of charge and readiness. When charging, a whine is audible, and the energy level indicator displays numbers counting up. When fully charged, a steady tone is audible, and the energy level indicator displays the available energy (Joules delivered to a 50Ω load). A charge done indicator on the apex paddle also lights when the unit is fully charged.

Indicators and tones are also provided to annunciate battery charging, battery condition, and SYNC mode.

A 50Ω test load is located internally. When 100 Joules or more are delivered to the test load, a TEST indicator lamp located between the paddles will flash. This verifies proper function of all defibrillation logic circuits, all energy delivery circuits, and the paddle set.

The Defibrillator module is equipped with both adult (80 sq cm) and pediatric/small adult (18 sq cm) external paddles. The pediatric paddles are located underneath the adult paddles. A quick release catch allows the adult electrodes to be removed, exposing the pediatric electrodes. There are several advantages to this paddle system including:

- Circumstances of chest trauma where the adult paddles are too large to be used.
- Adult paddle electrode surfaces can easily be replaced in case of damage, without the use of tools or opening the case.

ABOUT THE HP 43130M DEFIBRILLATOR MODULE — Continued

The defibrillator paddles (adult and pediatric), serve as both energy delivery devices and ECG sensing devices. When a Defibrillator Module is properly connected to a Monitor-Recorder module, paddles may be selected as the ECG source, and the ECG may be viewed and recorded without using lead wires. When paddles are used as the ECG source, the bandwidth is reduced to minimize artifact and baseline wander.

The Defibrillator module contains its own independent power supply and internal battery. The power supply function is independent of the Monitor-Recorder module (if and when connected).

SELF DIAGNOSTICS

The Defibrillator/Monitor-Recorder system uses microcontroller technology to control and monitor system operation. This advanced design enables the system to perform a self-diagnostic routine.

Critical circuits within the modules are monitored and checked periodically during operation.

- Each time the Monitor-Recorder is turned ON, proper operation of these circuits is verified, and noted by a brief "READY" message on the CRT. All indicators light for approximately one second at turn on. If a problem is detected, an ERROR message will be generated on the CRT screen in place of the READY message.
- Each time the Defibrillator module is turned on, all the LED indicators light for approximately one second and the energy display alternately flashes "HP" and "888". If a problem is detected, the energy display will indicate an ERROR message and high voltage circuit operation will be inhibited.

Should an ERROR condition occur, note the error code, turn the Defibrillator and/or Monitor-Recorder modules OFF, and notify appropriate service personnel.

SPECIFICATIONS

OPERATING, STORAGE AND SHIPMENT ENVIRONMENT

Both modules are designed and tested to meet all performance specifications in the following environment:

Operating temperature: 0°C to +45°C
Altitude: sea level to 15,000 feet
Humidity: 5 days at 95% RH 40°C
Storage: –30 to +65 C ; sea level to 50,000 feet

ECG recording paper should be stored at less than 40°C and 80% RH. The paper may be stored for short periods (up to a month) at –30 to +65°C and up to 95% RH. This is a limitation of all thermal papers, whether used with hot stylus or thermal array recorders.

SPECIFICATIONS — Continued

POWER REQUIREMENTS

Required Nominal Line Voltage: 100-255 Vac
Required Line Frequency: 47-63 Hz
Maximum Line Power: Defibrillator module (150 W), Monitor-Recorder module (60 W)
Maximum Line Current: Defibrillator module (2 A), Monitor-Recorder module (1 A)

SIZE AND WEIGHT

Net Weight and Volume:

Defibrillator/Monitor-Recorder (HP 43110MC): 50 lbs, 16x14x21 in. (2.7 cu. ft.)
Monitor-Recorder without case (HP 43200M): 25 lbs, 16x14x11 in. (1.4 cu. ft.)
Monitor-Recorder with case (HP 43200MC): 30 lbs, 16x14x14 in. (1.8 cu. ft.)

Shipping Weight and Volume:

Defibrillator/Monitor-Recorder (HP 43110MC): 68 lbs, 18.5x21x31 in. (7.0 cu. ft.)
Monitor-Recorder without case (HP 43200M): 39 lbs, 18.5x21x22 in. (4.8 cu. ft.)
Monitor-Recorder with case (HP 43200MC): 44 lbs, 18.5x21x25 in. (5.6 cu. ft.)

SPECIFICATIONS OF THE HP 43200M MONITOR-RECORDER MODULE

ECG Leads Amplifier:

Inputs: I,II,III,aVR,aVL,aVF,V using a 5 lead cable
Frequency Response: 0.05 to 100 Hz –3dB
Common Mode Rejection: > 90 db with 5kΩ imbalance
Input Offset Range: ±300 mVdc
Input Impedance: > 10 MΩ, < 1000 pF
Patient Isolation: > 10 MΩ at 10 Hz
Noise: < 30 µVp-p with gain set to 4000, RTI (referred to input)
Gain Settings: 250, 400, 650, 1000, 1300, 2000, 3000, 4000
Gain Accuracy: ±10 % all settings
Pace Pulse Detection: none

ECG Memory: 30 minutes, solid state (0.5 to 30 Hz bandwidth)
Display Size and Type: 5-inch (7.6 cm x 10.2 cm) diagonal CRT, 4 seconds of ECG data, non-fade, fixed trace.
CRT Sweep Speed: 25 mm/sec nominal.
CRT Frequency Response: 0.5 to 40 Hz at –3dB
Calibration Pulse: 1mV ±8% RTI
Heart Rate Display: Range 15 to 300 bpm
Default Alarm Limits: Lo - 40 bpm, Hi - 140 bpm
Heart Rate Alarms: Adjustable range, Lo - 15 to 270 bpm, Hi - 25 to 280 bpm
Recorder Type: Thermal Array
Recorder Paper Size: 50 mm x 30 m nominal
Recorder Paper Speed: 25 mm/sec ±5%
Automatic Recorder Runs: 10 sec (Alarm violation), 60 sec (Defib Charge), 10 sec (Defib Discharge), 2 sec (Disarm)
Recorder Mode: Real time (or playback)
Recorder Frequency Response: 0.05 to 100 Hz w/leads
Battery: 12V 2.9 Amp-hour nominal
Battery Charge Time: 2 hours for 90% capacity
Battery Capacity: 4 hours monitoring or 1 hour recording or any linear combination

SPECIFICATIONS — Continued

SPECIFICATIONS OF THE HP 43130M DEFIBRILLATOR MODULE

Discharge Waveform: Lown Waveform (damped sinusoidal)
Output Energy (delivered): 40, 70, 100, 200, 300, 360 Joules into 50Ω
Charge Control: Six front panel switches or Apex paddle button
Charge Time: < 10 sec to 360 Joules (fully charged battery)
Delivered Energy Display: Green LED, 3 digits
Armed Indicators: Charge done tone, charge done LED (apex paddle), delivered energy display
Paddles: Adult 80 sq. cm., Pediatric 18 sq. cm.
Synchronizer: Discharge < 60 msec after R-wave peak. (requires Monitor-Recorder module)

ECG Paddles Amplifier:

Frequency Response: 0.5 to 40 Hz –3dB
Common Mode Rejection: > 90 db with 1kΩ imbalance
Input Offset Range: ±300 mV DC
Input Impedance: > 100 kΩ, < 2000 pF
Patient Isolation: > 10 MΩ at 10 Hz
Noise: < 30 μVp-p with gain set to 4000, RTI (referred to input)
Gain Settings: 250, 400, 650, 1000, 1300, 2000, 3000, 4000
Gain Accuracy: ±10 % all settings
Pace Pulse Detection: none

STANDARD ACCESSORIES

ECG ruler, 1 EA (HP part number 1530-1239)
Electrode Lead Set (5-Lead), 1 EA (HP part number 43201-61610)
Holding strap kit ,1 KIT w/4 straps (HP part number 14030A)
Limb electrodes, 1 KIT w/4 electrodes (HP part number 9301-1149)
Operating Guide, Defibrillator/Monitor-Recorder , 1 EA (HP part number 43201-91908)
Recorder paper, 3 RL (HP part number 40453A - box of 10 rolls)
Redux gel, One tube (HP part number 0651-1024)
Redux paste, One tube (HP part number 0651-1008)
Service Manual, Defibrillator, 1 EA (HP part number 43131-91909)
Service Manual, Monitor - Recorder, 1 EA (HP 43201-91909)
Welsh electrode, 1 EA, (HP part number 14324A)

DEFIBRILLATOR ENERGY OUTPUT INFORMATION

The defibrillator stores sufficient energy to discharge 360 Joules into a 50Ω impedance. However, the actual energy delivered into a patient is a function of the total impedance to the defibrillator discharge. As a practical matter, the operator controls a large portion of this impedance by the quality of skin preparation, paddle placement, and pressure. If sufficient electrolyte is utilized, and pressure of 10-12 kilograms per paddle applied, then an impedance of approximately 50Ω would be expected with the average patient. In this case, the energy delivered to the patient would equal the delivered energy setting selected.

The output waveforms shown in the figure below indicate that with decreasing impedance, higher peak current is obtained. Recent clinical evidence indicates that the peak current value must reach a critical threshold for defibrillation, and should therefore be maximized. The primary method available to the operator to accomplish this is proper paddle application technique.

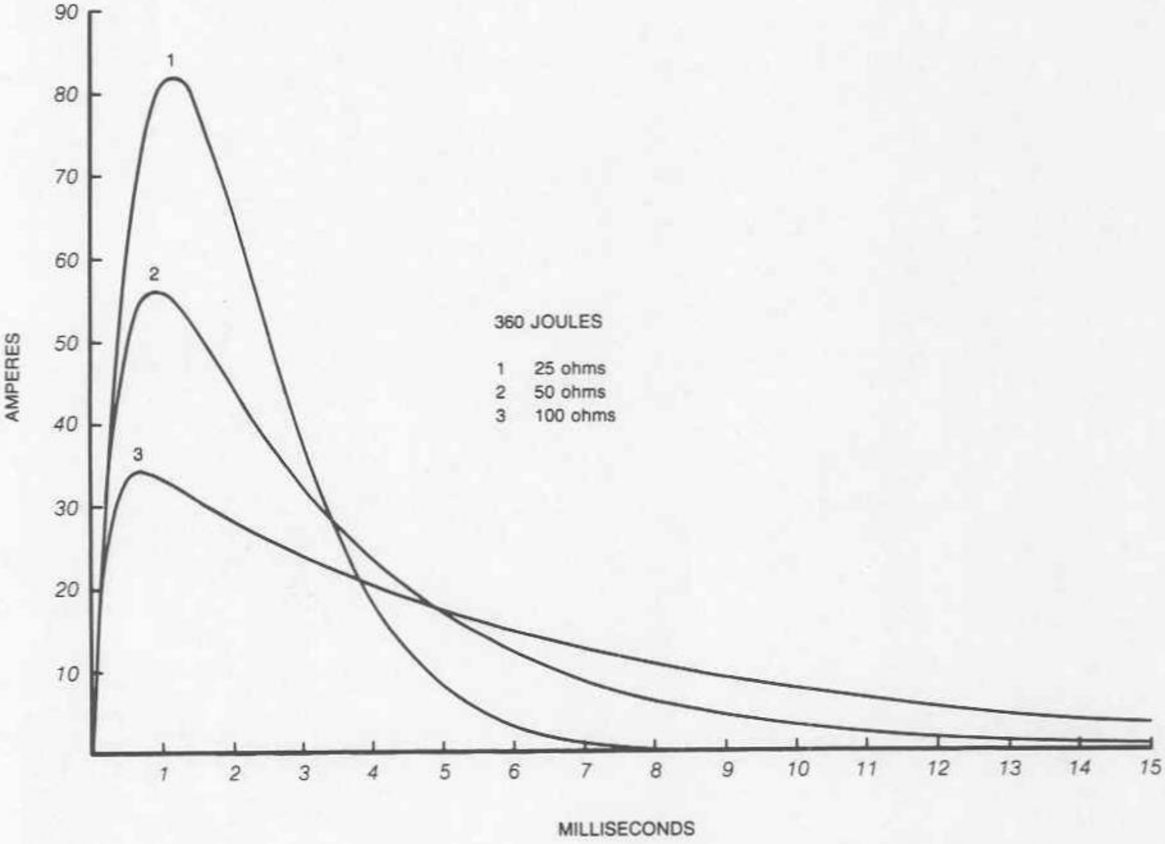


Figure 3. Defibrillator Output Energy waveforms

INITIAL INSPECTION

Carefully inspect each shipping container for damage. If the shipping container or cushion material is damaged, it should be kept until the contents have been checked for completeness and the instrument has been checked for mechanical and electrical integrity.

STORAGE AND SHIPMENT

ENVIRONMENT

Defibrillator and Monitor-Recorder modules should be stored in a clean, dry environment. The environmental limitations for both storage and shipment are –30 to +65°C, 0 to 50,000 feet, and < 95% RH 40°C.

PREPARATION

The Defibrillator and Monitor-Recorder modules can be stored for long periods of time provided proper precautions are take prior to and during storage. Procedures are provided for both short and long term.

- SHORT TERM (less than 6 months):
  1. Perform Section 8, Operational Checks to verify unit is functioning.
  2. Connect unit from AC power for a minimum of 24 hours with POWER key set to OFF/RECHARGE to fully charge battery.
  3. Disconnect unit to AC power for a minimum of 24 hours. With AC power cord unplugged, verify battery voltage is >12.5V (Section 6). If battery voltage incorrect, notify service personnel.
  4. Remove Redux® gel, paste, cream, etc.
  5. Remove thermal paper (Section 7). Leave Printhead latch unlocked.
  6. Clean unit and accessories.
- LONG TERM (more than 6 months): Perform same procedure as Short Term, then remove battery. See Service manual for instructions.

NOTE

Equipment being retrieved from storage may require several battery recharge/discharge cycles before maximum battery capacity is restored.

PACKAGING

Containers and materials used for original shipment of your HP 43110MC are specifically designed for the instrument and are not readily available through Hewlett-Packard sales offices; it is recommended that you keep the packing materials for future use. If the instrument is returned to Hewlett-Packard for servicing, attach a tag indicating the product model number, serial number, return address, and a description of the problems encountered and service required. Mark the container FRAGILE to ensure careful handling. In every correspondence, refer to the instrument by product number and full serial number (e.g. HP 43110MC, serial number 2400A00000).

Follow these general instructions when re-packaging with commercially available materials:

- Wrap the instrument in heavy cushioning material.
- Use a strong shipping container. A double-wall carton made of 160 kilogram test material is adequate.
- Use enough shock absorbing material (3 or 4 inch layer) around all sides of the instrument to provide firm cushioning and to prevent movement inside container. Protect the control panel with cardboard.
- Seal the shipping container securely.

OPERATING CONTROLS AND INDICATORS

Monitor-Recorder Module and Defibrillator Module operating controls and indicators are presented below by module.

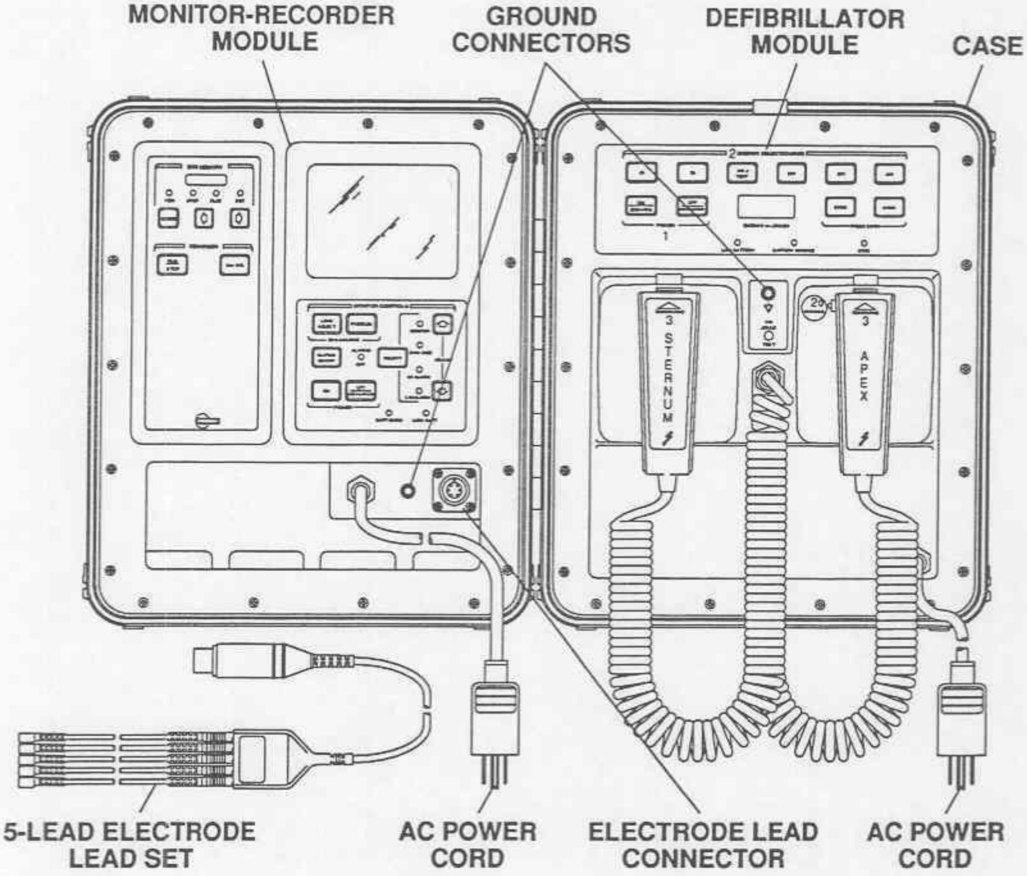

MONITOR-RECORDER MODULE
GROUND CONNECTORS
DEFIBRILLATOR MODULE
CASE
STERNUM
APEX
5-LEAD ELECTRODE LEAD SET
AC POWER CORD
ELECTRODE LEAD CONNECTOR
AC POWER CORD

Figure 4. Defibrillator/Monitor-Recorder Controls and Indicators

DEFIBRILLATOR/MONITOR-RECORDER

AC POWER CORDS: Two separate cables, with three prong male plugs. Used to connect the Defibrillator module and Monitor-Recorder module to a 100 - 255 Vac, 47 - 63 Hz AC source for operation and/or battery charge.

GROUND CONNECTORS: Two separate female connectors used to connect the Defibrillator module and/or Monitor-Recorder module to ground. Used during battery operation, or when AC power cord ground pin not connected, if grounding is required.

ELECTRODE LEAD CONNECTOR: Located on Monitor-Recorder module. Six pin female connector used to connect electrode lead set.

ELECTRODE LEAD SET: Five lead cable used to connect the patient to the Monitor-Recorder module. Six pin male connector attaches lead to Monitor-Recorder Module. Five disposable electrodes attach to lead end to complete patient contact.

CASE: Provides protection for the modules and also provisions for optical communication. Contains latches, fasteners, handles, hangers, and pressure relief valve necessary to safely transport and operate instrument.

MONITOR-RECORDER MODULE OPERATING CONTROLS AND INDICATORS

Monitor-Recorder module controls are grouped under five major functional headings.

1. The MONITOR CONTROLS contain the switches and indicators necessary to control module power, ECG source, beeper volume, ECG size, alarm settings, and battery status.
2. The CRT SCREEN displays the ECG waveform (real time or playback), patient information, equipment status, and data messages to the operator.
3. The ECG MEMORY controls contain the switches and indicators necessary to select and activate/deactivate the thirty minute ECG memory.
4. The RECORDER controls contain the switches and indicators necessary to activate/deactivate the diagnostic stripchart recorder.
5. The STRIPCHART RECORDER provides a hard copy of the ECG waveform (real time or playback) along with data messages and operator information printed along the edge.

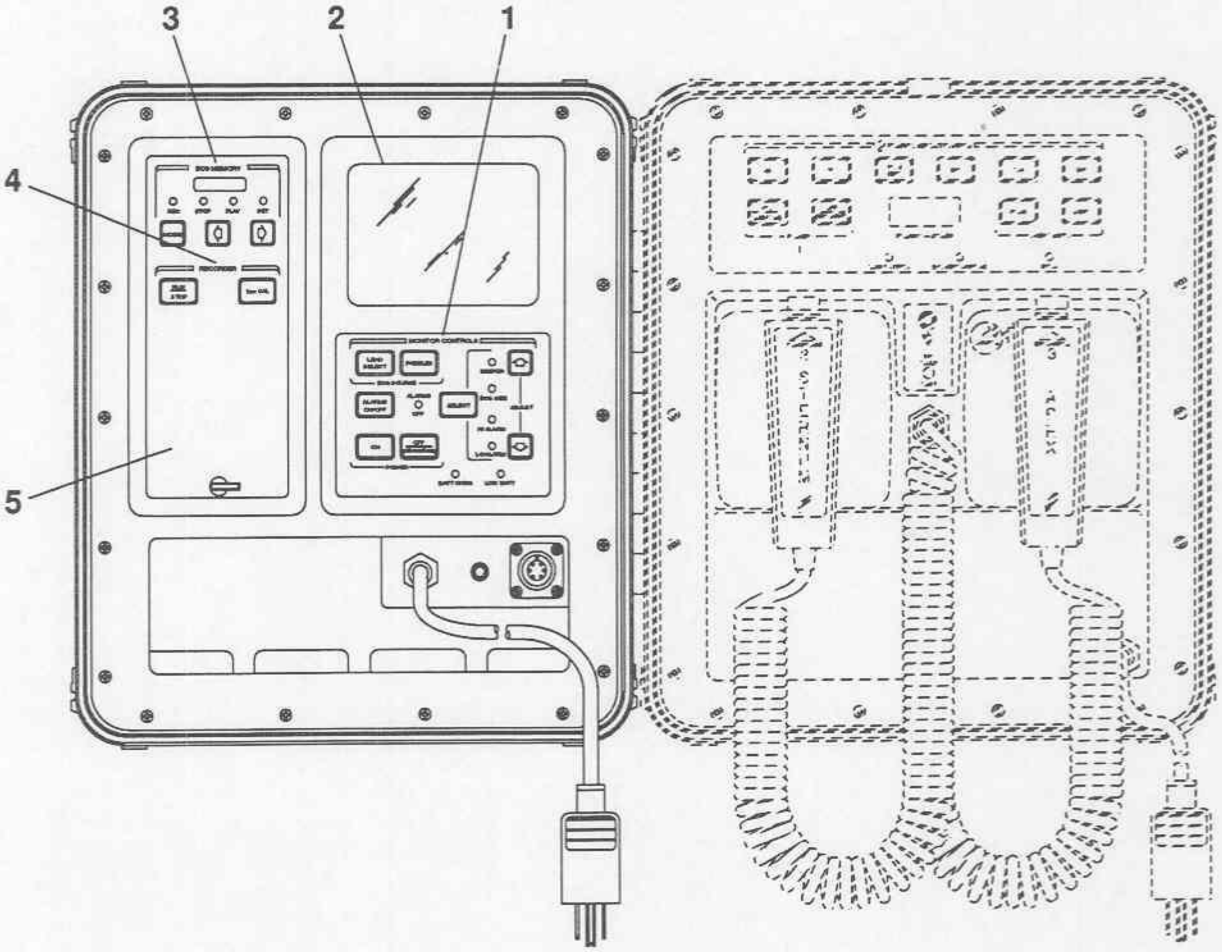
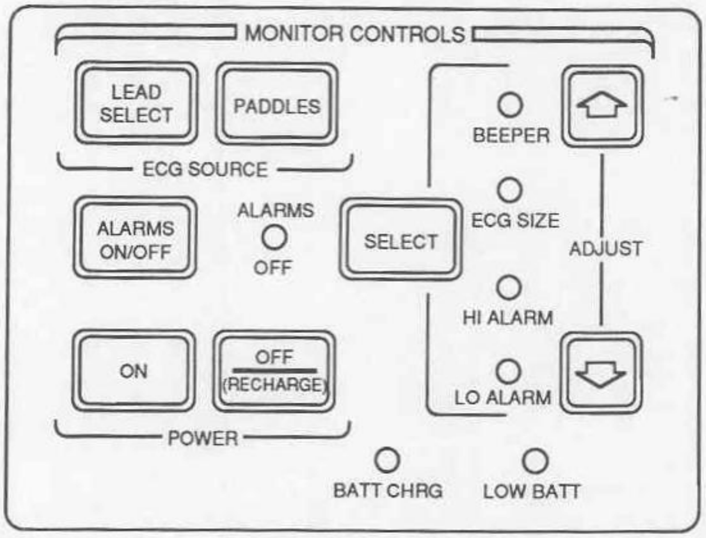


Figure 5. Monitor-Recorder Controls and Indicators



1. MONITOR CONTROLS

POWER ON key: Turns the Monitor-Recorder module on. All the LED indicators will light and a tone will sound for approximately one second. If AC power cord is connected to AC source, module will operate on AC. If AC power cord is not connected, module will operate on internal battery.

POWER OFF/RECHARGE key: Turns the Monitor-Recorder module off. If AC power cord is connected to AC source, BATT CHRG indicator will illuminate and internal battery will charge.

ECG SOURCE LEAD SELECT key: Selects and activates the electrode lead set (5-lead) as the ECG SOURCE. Press LEAD SELECT switch as required to sequentially change the ECG SOURCE between leads I, II, III, aVR, aVL, aVF, and V. The CRT screen will display lead selected. If PADDLES key is selected, pressing LEAD SELECT will return to the last lead selected.

ECG SOURCE PADDLES key: Selects and activates the Defibrillator Paddles as the ECG SOURCE. The CRT screen will display P when selected. Defaults to PADDLES when module is turned on. If a Defibrillator module is not properly connected, the CRT screen will display "NO DEFIB".

ALARMS ON/OFF key: Activates and deactivates the heart rate alarms. The red ALARMS OFF LED is on when the alarms are off. Defaults to OFF when module is turned on.

If Alarms are ON and violated, a continuous alarm tone sounds, the stripchart recorder starts, the Heart Rate digits on the CRT flash, and the ECG memory begins its record run.

ALARMS OFF INDICATOR: When red LED is on, indicates that the heart rate alarms are deactivated. When off, indicates that the heart rate alarms are activated. Defaults to ON when module is turned on.

SELECT key: Press as required to select BEEPER volume, ECG SIZE, HI ALARM, or LO ALARM. When selected, indicator will light and the present stored parameter can be adjusted using the UP and DOWN arrow keys.

BEEPER VOLUME INDICATOR: Controlled by the SELECT key. When green LED is on, pressing the UP/DOWN arrow keys will adjust the BEEPER volume (off is possible). Defaults to ON with medium volume when module is turned on. Automatically returns to ON one minute after ECG SIZE, HI, or LO ALARM are selected and/or changed.

With LED on, press and hold both UP ARROW and DOWN ARROW keys to display battery voltage on CRT.

ECG SIZE INDICATOR: Controlled by the SELECT key. When green LED is on, manual ECG size is selected and changed by pressing the UP/DOWN arrow keys. Range from 2.5 mm/mV to 40.0 mm/mV. Defaults to automatic ECG size (LED OFF) when module is turned on.

Auto-size selects an ECG gain which results in an approximately one inch tall normal sinus rhythm as measured from the baseline to the peak of the R wave.

NOTE

If the ECG SIZE is selected and changed, the module must be turned OFF then ON to return to the automatic ECG size mode.

HI ALARM LIMIT INDICATOR: Controlled by the SELECT key. When green LED is on, pressing the UP/DOWN arrow keys will adjust the HI ALARM limit. Defaults to 140 bpm (LED to OFF) when module is turned on. When selected (LED to ON), both LO and HI limits are displayed on the CRT, with the HI limit flashing. Pressing the UP/DOWN arrow keys will change the limit from 25 to 280 bpm. HI rate is always limited to 10 bpm more than the selected LO rate (e.g., if LO is set to 75, minimum HI is 85).

LO ALARM LIMIT INDICATOR: Controlled by the SELECT key. When green LED is on, pressing the UP/DOWN arrow keys will adjust the LO ALARM limit. Defaults to 40 bpm (LED to OFF) when module is turned on. When selected (LED to ON), both LO and HI limits are displayed on the CRT, with the LO limit flashing. Pressing the UP/DOWN arrow keys will change the limit from 15 to 270 bpm. LO rate is always limited to 10 bpm less than the selected HI rate (e.g., if HI is set to 75, maximum LO is 65).

UP ARROW key: Used to increase the present value of the selected function (LED to ON). Increases BEEPER volume, ECG SIZE, HI ALARM limit, or LO ALARM limit. Press and release to increase by one increment, or press and hold to increase by numerous increments.

Press and hold both UP ARROW and DOWN ARROW keys with BEEPER LED on to display battery voltage on CRT.

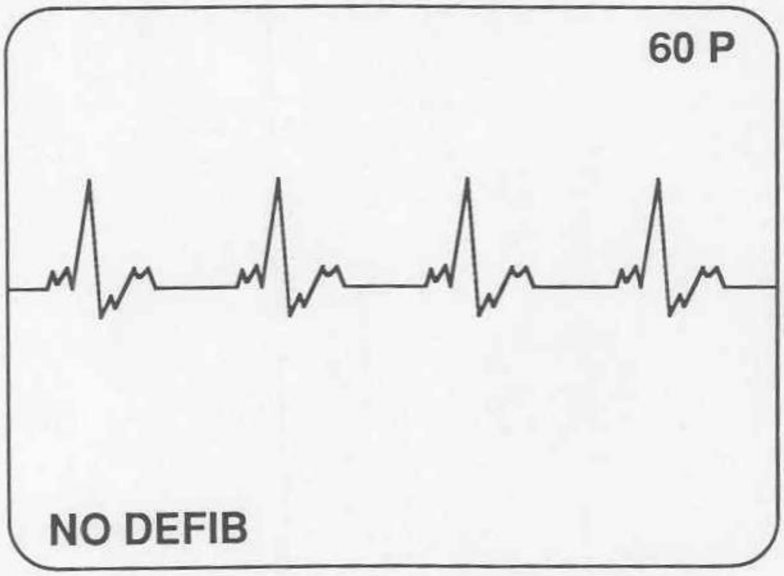
DOWN ARROW key: Used to decrease the present value of the selected function (LED to ON). Decreases BEEPER volume, ECG SIZE, HI ALARM limit, or LO ALARM limit. Press and release to decrease by one increment, or press and hold to decrease by numerous increments.

Press and hold both UP ARROW and DOWN ARROW keys with BEEPER LED on to display battery voltage on CRT.

BATT CHRG INDICATOR: When green LED is on, indicates that the module is connected to an AC power source and that the internal battery is charging. Will remain on with POWER ON/OFF in any position.

LOW BATT INDICATOR: When red LED is on, indicates that the battery operation time is running low. A minimum of 30 minutes of monitoring time remains when the indicator first lights.

Press and hold both UP ARROW and DOWN ARROW keys with BEEPER LED on to display battery voltage on CRT.



2. CRT SCREEN: The CRT is used to display 4 seconds of a fixed trace ECG waveform, patient information, and data messages. A tone accompanies the display information as follows:

- A short tone sounds with each detected systole.
- A continuous tone is sounded when an alarm condition occurs.
- A triple beep sounds to alert the operator to view the CRT screen for a message.

CRT Display Messages: The following is a list of display messages and the location as shown on the CRT.

- **ECG Source Indicator:** The selected ECG source is indicated in the upper right hand corner of the CRT. I, II, III, aVR, aVL, aVF, or V displayed indicates which leads of the Electrode Lead Set are activated. P displayed indicates Defibrillator paddles are selected.

- **Heart Rate Indicator:** The current three-digit Heart Rate is indicated in the upper right area of the CRT screen. Heart Rate flashes when an alarm condition occurs. Range of the rate meter as displayed is from 15 to 300 bpm.

WARNING—PACEMAKER PATIENTS

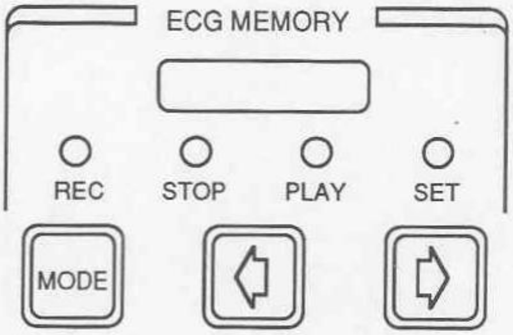
Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest or some arythmias. Do not rely entirely upon the rate meter alarms. Keep Pacemaker patients under close surveillance. This instrument does not reject pacemaker pulses.

NOTE

The QRS detectors may inadvertently be triggered by noise, pacemaker pulse, etc. The operator must guard against the potential hazard by correctly positioning the leads and verifying correct heart rate metering.

- **Sync Marker Indicator:** A bright dot is superimposed on the R wave at the point at which synchronization will occur when used with the Defibrillator module in SYNC mode.
- **ERROR xx** is momentarily displayed in the lower left hand corner to indicate a unit malfunction. When this message appears, record the number (xx), press the POWER OFF/RECHARGE key, and notify service personnel.
- **LOW BATTERY** is displayed in the lower left hand corner when the battery is in need of recharging. When this message first appears there is a minimum of 30 minutes monitoring time available.
- **LOW PAPER** is momentarily displayed in the lower left hand corner along with three audible beeps when the paper supply is low. When this message first appears there is a minimum of 10 ft of paper remaining.
- **NO DEFIB** is displayed in the lower left hand corner when a Defibrillator module is not connected or turned on.
- **NO PAPER** is momentarily displayed in the lower left hand corner along with three audible beeps when printer has run out of paper.
- **PLAY ALARM** is momentarily displayed in the lower left hand corner when PLAYback mode is selected, and an alarm has occurred and is being displayed on the CRT screen.
- **PLAY BEGIN** is momentarily displayed in the lower left hand corner when PLAYback mode is selected to indicate the beginning of ECG MEMORY. Also displayed when the LEFT ARROW key has been depressed enough to rewind the ECG MEMORY to the start.
- **PLAY END** is displayed in the lower left hand corner when PLAYback mode is selected and the ECG MEMORY is at the end. Also displayed when the RIGHT ARROW key has been depressed enough to fast forward the ECG MEMORY to the end.

- **PLAYBACK** is displayed in the lower left hand corner when the Monitor-Recorder is displaying/printing ECG data which has been stored in the ECG MEMORY. When on, the data being viewed is **NOT** real time ECG.
- **READY** is momentarily displayed in the lower left hand corner at turn on to indicate self tests have passed and Monitor-Recorder module is operational.
- **RECORD** is momentarily displayed in the lower left hand corner when SET mode is first selected to enter or check post-alarm time.
- **STOP** is momentarily displayed in the lower left hand corner when STOP mode is first selected. Indicates the ECG memory is off.
- **SYNC** is displayed in the lower left hand corner when the Monitor-Recorder is in synchronous cardioversion mode. SYNC operation requires a properly connected, functional Defibrillator module.
- **SYNC LOST** is momentarily displayed in the lower left hand corner along with three audible beeps when SYNC operation is abnormally terminated. SYNC operation requires a properly connected, functional Defibrillator module.
- **USE LEADS** is momentarily displayed in the lower left hand corner when in SYNC mode and indicates that SYNC mode has been selected with PADDLES selected as the ECG SOURCE. Paddles can be used as ECG SOURCE, but is **NOT** recommended because of increased ECG artifact associated with monitoring via the Paddles. Artifact may incorrectly trigger the R wave detector and result in cardioversion occurring at an undesirable time. SYNC operation requires a properly connected, functional Defibrillator module.



3. ECG MEMORY:

NOTE

Turning the Monitor-Recorder module POWER to OFF will erase ECG MEMORY. There is no indication to the operator, other than distortions in ECG playback, that the data in ECG MEMORY is lost or corrupted.

MODE key: Press as required to select RECord, STOP, PLAYback, and SET modes of operation for the ECG MEMORY. When selected, the mode indicator will turn ON. The mode indicator must remain ON for two seconds before the selected mode is activated.

REC INDICATOR: Controlled by the MODE key. When green LED is on, the ECG MEMORY is in the RECording mode. Defaults to ON when module is turned on. Recording time is specified as pre-alarm and post-alarm, and entered using SET mode. The ECG MEMORY Total record time is 30 minutes in a FIFO (first-in-first-out) type electronic memory. When REC LED is on, and if the alarms are on and violated, the ECG memory will begin to record for the time as selected by SET mode.

NOTE

During RECord, the ECG MEMORY will only record ECG data from the lead vector currently selected and displayed on the CRT screen. The remaining (unselected) leads will not be recorded. In addition, the ALARM, CHARGE, DISCHARGE, and DISARM annotations normally printed on the recorder during an automatic run will not be recorded.

STOP INDICATOR: Controlled by the MODE key. When green LED is on, the ECG MEMORY is in the STOP mode, and will not record or playback data. Anytime recording is stopped (manually or by an alarm), one bi-polar marker pulse will be inserted to show different recorded sections and/or the end of information.

PLAY INDICATOR: Controlled by the MODE key. When green LED is on, the ECG MEMORY is in the PLAYback mode. During playback, both ECG wave and information are displayed on the CRT, and if selected, the stripchart recorder. The CRT will display the message "PLAYBACK" to indicate the data being displayed is **NOT** real time but the recorded data. "PLAY ALARM" is displayed at the point where the alarm(s) occurred. The ECG MEMORY BARGRAPH Indicator displays the segment currently being shown. LEFT and RIGHT ARROW keys can be used to fast forward and rewind as necessary.

CAUTION

Loss of recorded alarm data can be caused by activating the SET or REC modes. When selecting PLAYback mode, the operator may have to cycle through the SET and REC modes. If either of these modes remain selected for more than two seconds, they will become active, and cause a recorded alarm condition to be erased.

NOTE

During playback, the BEEPER is off and cannot be adjusted.

Playback is affected by other events as follows:

- Selecting PLAY after an alarm has occurred will cause playback to start at the alarm point.
- Selecting PLAY before an alarm has occurred, will cause playback to start one minute before the current time, or at the beginning of data in ECG memory, whichever is earlier.
- If the Defibrillator module is connected and the SYNC or CHARGE key is actuated during playback, the unit will automatically switch to real time display mode.
- If an alarm occurs during PLAY (if alarms are on), then the unit will automatically switch to real time display mode.

SET INDICATOR: Controlled by the MODE key. When green LED is on, the ECG MEMORY is in the SET mode. When SET mode is activated (LED to ON), the LEFT and RIGHT ARROW keys are used to select and adjust the amount or length of time (0-30 minutes) that recording will continue after a heart rate alarm (post-alarm time). The ECG MEMORY BARGRAPH indicator displays the post-alarm and pre-alarm record time. Defaults to 25 minutes post-alarm and 5 minutes of pre-alarm time when module is turned on.

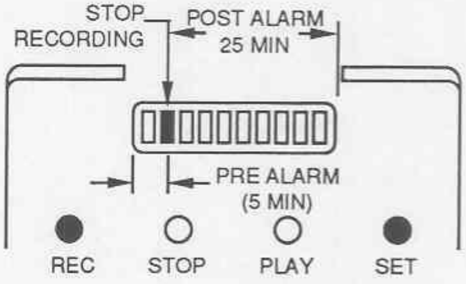
NOTE

If SET is selected for more than 10 seconds without entering a time using the LEFT/RIGHT ARROW keys, the REC mode will automatically be selected.

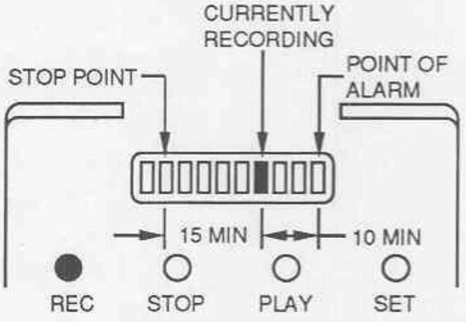
ECG MEMORY BARGRAPH INDICATOR: Ten segment green LED bargraph provides data dependent on the mode selected. Each segment represents about three minutes of the total thirty minutes available.

NOTE

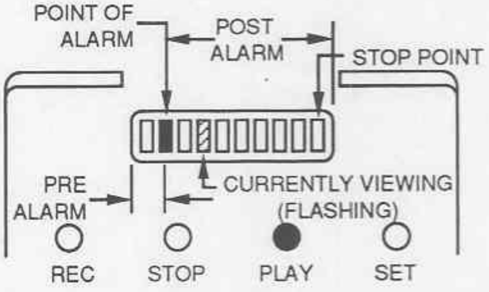
In all the examples shown below, the default time of 25 minutes post-alarm and 5 minutes pre-alarm is used.



- In SET mode, the illuminated segment is used to display the stop recording point. The number of segments to the right of the illuminated segment indicate the currently selected post-alarm time and the number of segments to the left of the illuminated segment indicate pre-alarm time.



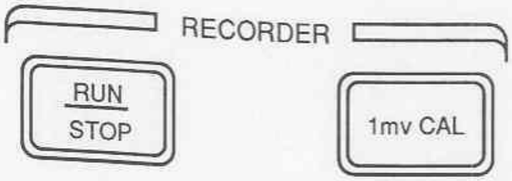
- In RECord mode (REC LED to ON), all segments will be off until an alarm occurs. At that time the far right segment will illuminate, and will move towards the left as the recording continues after the alarm. By observing the position of the illuminated LED segment, the operator can determine how much data is available before and after the alarm. When the selected stop recording point is reached, the illuminated segment of the bar-graph will stop moving left, and be at the same position selected using the SET mode. The REC indicator will go out and the STOP indicator will illuminate.



- In PLAYback mode (PLAY LED to ON): When first selected, the continuously on segment indicates the point at which the recording was stopped (either automatically or manually). After ~two seconds, the PLAYback begins at the point the alarm occurred. The flashing segment indicates what portion of the memory is currently being viewed and moves from the left to the right. By observing the position of the flashing LED segment, the operator can determine what portion of memory is currently being displayed. The continuously on segment shows the position of the alarm.

LEFT ARROW key: Changes data depending on the mode selected. In PLAYback mode (PLAY LED to ON), press and hold to rewind the stored data (both ECG wave and information). In SET mode (SET LED to ON), increases the amount of post-alarm information to be stored. Press and release to increase by one segment, or press and hold to increase by numerous segments.

RIGHT ARROW key: Changes data depending on the mode selected. In PLAYback mode (PLAY LED to ON), press and hold to fast forward the stored data (both ECG wave and information). In SET mode (SET LED to ON), decreases the amount of post-alarm information to be stored.



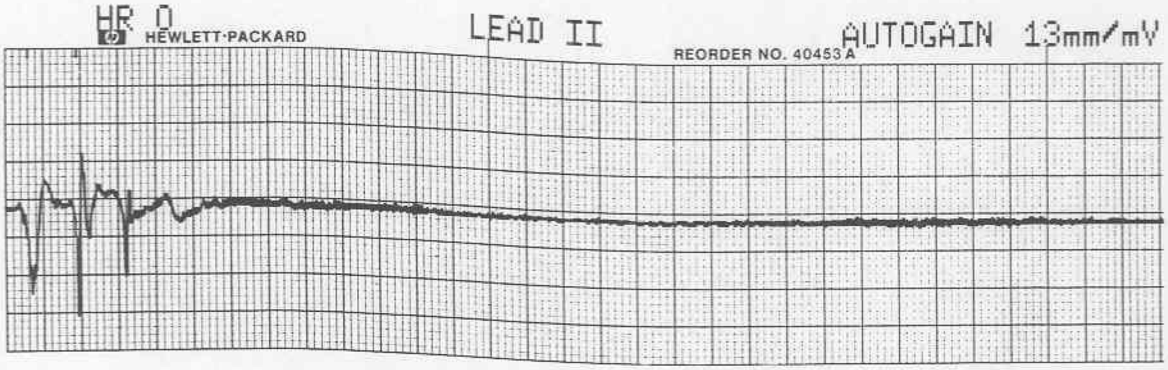
4. RECORDER

RUN/STOP key: Starts and stops the stripchart recorder. Press once to start the recorder when not running. Press once to stop the recorder when running (even if started automatically). Defaults to OFF when module is turned on.

1mV CAL key: When pressed, generates a 1mV pulse one centimeter wide. Pulse is displayed on both the CRT and stripchart recorder (if on).

NOTE

If gain is set to ≥30 mm/mV, the CAL pulse will be clipped on both the CRT screen and the recorder output.



5. STRIPCHART RECORDER: A thermal array annotating recorder provides both the ECG waveform (real or playback) along with messages and information printed along the edge. The recorder automatically activates each time the Defibrillator module is charged, discharged, or disarmed; and whenever the heart rate alarm is violated. Paper status is provided to the operator by LOW PAPER and NO PAPER messages displayed on the CRT screen.

Recorder Messages: The following is a list of messages printed on the thermal paper.

- **Sync Marker Indicator:** A short line prints in the margin at the point at which synchronization will occur when used with the Defibrillator module in SYNC mode.
- **AUTOGAIN xxx mm/mV** is printed every 10 seconds to indicate that the ECG size setting is in automatic. Also prints the size currently selected. xxx is 2.5, 4.0, 6.5, 10, 13, 20, 30, or 40.
- **CHARGE** is printed once when Defibrillator module is charged to any level. Requires a properly connected, functional Defibrillator module.
- **DISARM** is printed once when Defibrillator module is discharged using the DISARM key (on Defibrillator module). Also prints when an automatic internal discharge occurs (60 seconds after charge). Requires a properly connected, functional Defibrillator module.
- **DISCHARGE** is printed once when Defibrillator module is discharged using the DISCHARGE keys (on Defibrillator paddles). Requires a properly connected, functional Defibrillator module.
- **LEAD xxx** is printed every 10 seconds when using the electrode lead set as the ECG source. xxx = I, II, III, aVR, aVL, aVF, or V as selected by the LEAD SELECT key.
- **PADDLES** is printed every 10 seconds when using the Defibrillator module paddles as the ECG source as selected by the PADDLES key. Requires a properly connected, functional Defibrillator module.
- **PLAYBACK** is printed every 10 seconds when ECG is printing from the 30-minute ECG memory.
- **SYNC** is printed every 10 seconds when in SYNC mode. SYNC operation requires a properly connected, functional Defibrillator module.
- **xxx mm/mV** is printed every 10 seconds when to indicate that the ECG size setting is in manual and the size currently selected. xxx is 2.5, 4.0, 6.5, 10, 13, 20, 30, or 40.

DEFIBRILLATOR MODULE OPERATING CONTROLS AND INDICATORS

Defibrillator module controls are grouped under two physical location headings.

1. The PANEL controls contain the switches and indicators necessary to control module power, energy selection, SYNC operation, charge and disarm, charge status, and battery status.
2. The PADDLE controls contain the switches and indicators necessary to charge and discharge the Defibrillator.

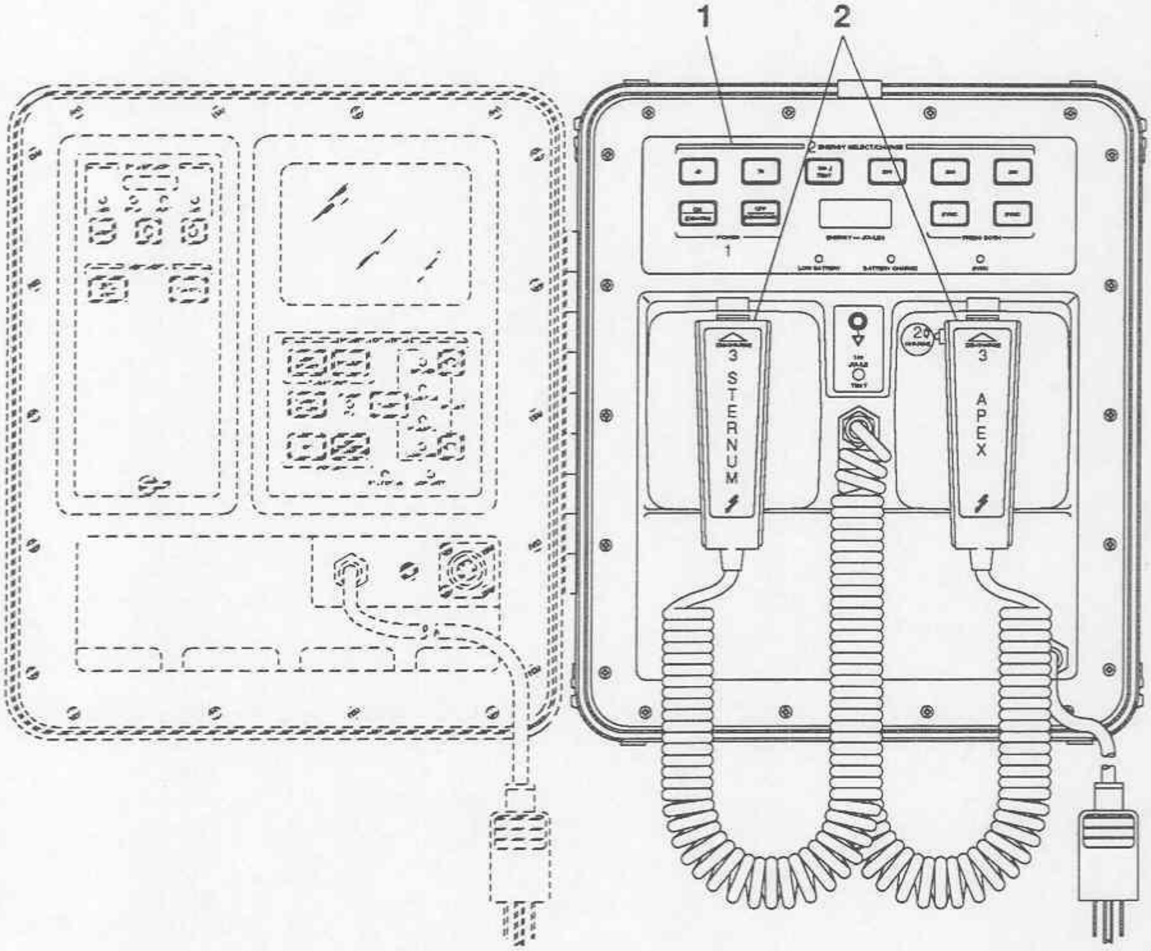
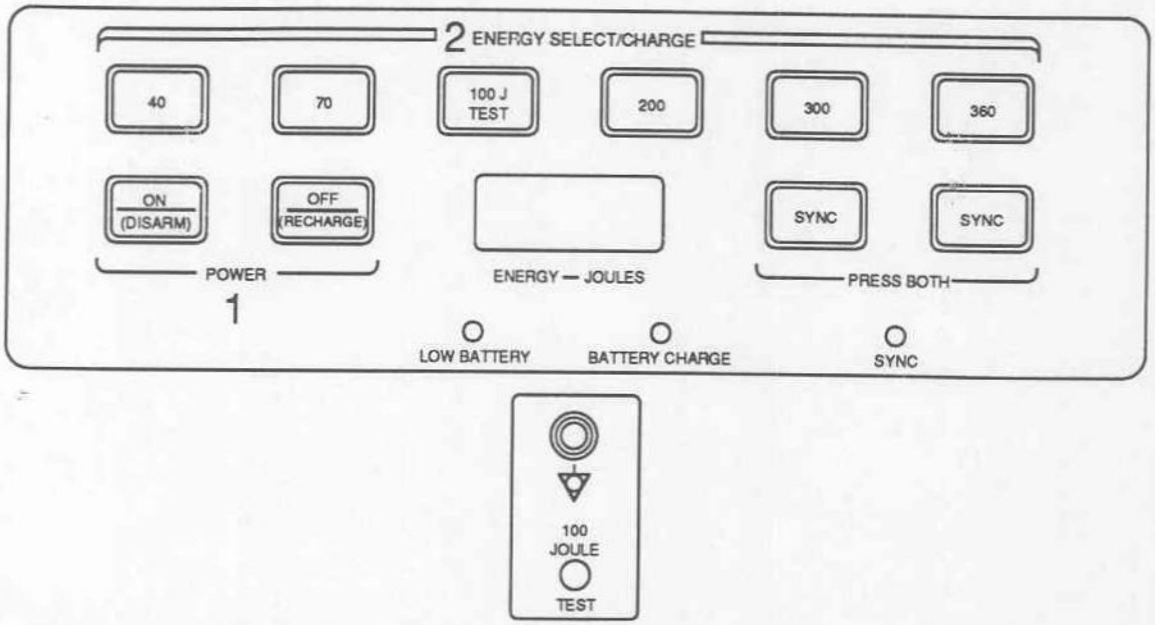


Figure 6. Defibrillator Controls and Indicators



1. PANEL CONTROLS

POWER ON/DISARM key: Dual function key.

- Turns the Defibrillator module on. All the LED indicators will light and a tone will sound for approximately one second. If AC power cord is connected to AC source, module will operate on AC. If AC power cord is not connected, module will operate on internal battery.
- When defibrillator is charged or charging, pressing key will cause Defibrillator to disarm (discharge internally). If a Monitor-Recorder module is properly connected, the stripchart recorder will automatically begin a 10 second run.

Simultaneously pressing the ON/DISARM and right-hand SYNC key causes the battery voltage to be shown on the ENERGY-JOULES display.

POWER OFF/RECHARGE key: Turns the Defibrillator module off. The defibrillator will internally discharge any stored energy when key is pressed. If AC power cord is connected to AC source, BATTERY CHARGE indicator will illuminate and internal battery will charge.

ENERGY SELECT/CHARGE keys: Selects the energy level (40, 70, 100J/TEST, 200, 300, 360 Joules) and starts the defibrillator charge sequence. Continues charging until specified level is reached; DISARM key is pressed; or OFF/RECHARGE key is pressed. The ENERGY-JOULES display shows charge level and tone sounds when fully charged.

50 seconds after charging is completed tone will beep indicating that the energy will be dumped internally after another 10 seconds if an external discharge is not performed. If a Monitor-Recorder module is properly connected, the stripchart recorder will automatically begin a 60 second run.

SYNC keys: Used to enter or exit the synchronized cardioversion mode. Both keys must be pressed simultaneously. SYNC operation requires a properly connected, functional Monitor-Recorder module.

- SYNC MODE OFF: When keys are pressed, the SYNC LED will light, SYNC mode will be entered, and SYNC will be displayed on the CRT (Monitor-Recorder module).
- SYNC MODE ON: When keys are pressed, the SYNC LED will go out, SYNC mode will be exited, and CRT (Monitor-Recorder module) will no longer display SYNC.

If SYNC is selected and a Monitor-Recorder module is not properly connected, SYNC mode will not be entered, the SYNC LED will flash briefly, and the ENERGY-JOULES display will flash the error message "EEE".

Simultaneously pressing the ON/DISARM and right-hand SYNC keys causes the battery voltage to be shown on the ENERGY-JOULES display.

ENERGY-JOULES DISPLAY: Three digit green numeric display provides operator information about Defibrillator status.

- At turn-on, display will alternately flash "HP" and "888", and then display "0".
- When the ENERGY SELECT/CHARGE keys are pressed, the display will count up as the defibrillator is charged, and then display the final energy level reached when charging is complete. Level is displayed in Joules delivered to a 50Ω load.
- When the DISARM key is pressed (defibrillator charged), the display will count down as the defibrillator is internally discharged.
- Displays "EEE" when sync mode is selected without a Monitor Module connected.
- Displays "E2 through E8" to indicate a hardware failure. Record error indication and notify service personnel.
- Displays internal battery voltage when the ON/DISARM and right-hand SYNC keys are pressed simultaneously.

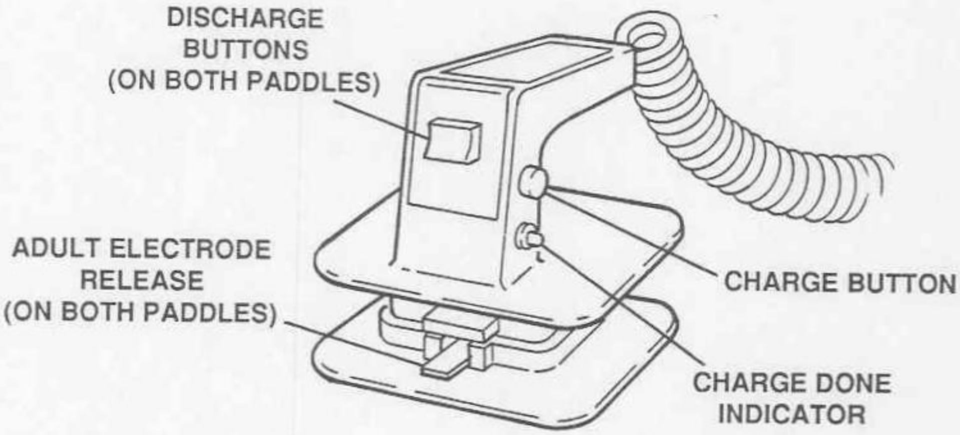
LOW BATT INDICATOR: When red LED is on, indicates that the battery operation time is running low. A minimum of 5 full energy discharges remain when the indicator first lights.

Simultaneously pressing the ON/DISARM and right-hand SYNC keys causes the battery voltage to be shown on the ENERGY-JOULES display.

BATTERY CHARGE INDICATOR: When green LED is on, indicates that the module is connected to an AC power source and that the internal battery is charging. Will remain on with POWER ON/OFF in any position.

SYNC INDICATOR: When amber LED is on, indicates defibrillator is in the synchronized mode. When in synchronized mode, amber LED flashes off with each detected R wave. SYNC operation requires a properly connected, functional Monitor-Recorder module.

TEST INDICATOR: Neon lamp, located between the paddle storage/test wells, flashes when at least 100 Joules is discharged into the internal 50Ω test load.


DISCHARGE BUTTONS (ON BOTH PADDLES)
ADULT ELECTRODE RELEASE (ON BOTH PADDLES)
CHARGE BUTTON
CHARGE DONE INDICATOR

2. PADDLE CONTROLS

CHARGE button: Starts the defibrillator charge sequence.

- If pressed for the first charge request since power up, will charge to 200 Joules.
- If pressed for the second or more charge request since power up, will charge to the previously selected energy level.

Continues charging until previously selected energy level is reached (or 200 Joules if first since turn-on); DISARM key is pressed; or OFF/RECHARGE key is pressed. The ENERGY-JOULES display shows charge level and tone sounds when fully charged. 50 seconds after charging is completed tone will beep indicating that the energy will be dumped internally after another 10 seconds if no external discharge is performed. If a Monitor-Recorder module is properly connected, the stripchart recorder will automatically begin a 60 second run.

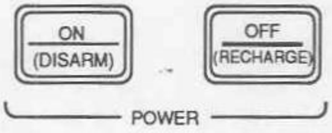
DISCHARGE buttons: Two buttons (one on each paddle) pressed simultaneously delivers a countershock through the paddles. If paddles are in defibrillator well, energy is discharged internally. In SYNC (synchronous cardioversion) mode, the two buttons must be depressed and held until the next detected R wave causes the Defibrillator module to fire.

CHARGE DONE INDICATOR: When red LED is on, indicates that the defibrillator is completely charged to the selected level. In addition, a charge done tone sounds continuously when charging is complete, and the available energy is displayed on the numeric ENERGY-JOULES display.

ADULT ELECTRODE RELEASE: Used to release the adult electrode, revealing the child/small adult electrode. Depress and slide off in one motion to remove.

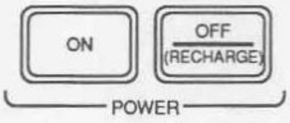
TURN ON DEFIBRILLATOR MODULE POWER

Press the POWER ON key. Verify all indicators light and a tone sounds for one second. Verify the ENERGY-JOULES display flashes "HP" and "888", then displays "0".



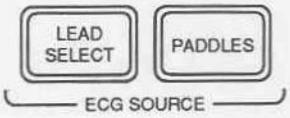
TURN ON MONITOR-RECORDER MODULE

Press the POWER ON key. Verify all indicators light and a tone sounds for one second. Verify the CRT screen display flashes "READY", and displays "O P" and a moving trace.



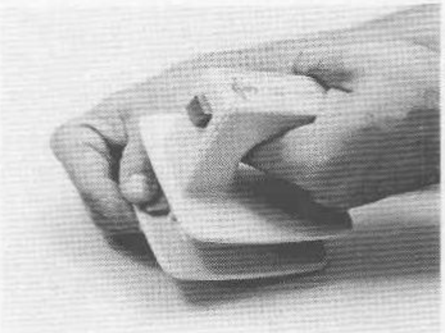
SELECT ECG SOURCE

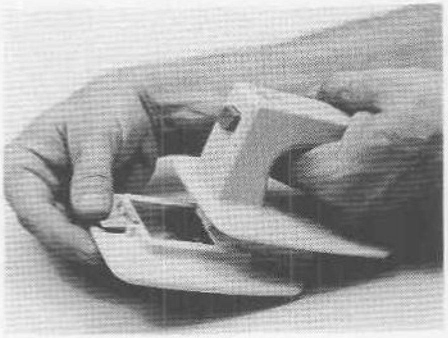
- To **immediately view** the ECG, apply the paddle electrodes to the patient's chest.
- For **better quality ECG**, connect the patient leads and press LEAD SELECT key until desired lead and the ECG are displayed on the CRT screen.



PREPARE PADDLES

- Remove the paddles from their holders by grasping the handles, tilting up, and pull away.
- If small adult/child electrodes are needed, depress release button and remove adult electrodes.





PREPARE PADDLES — Continued

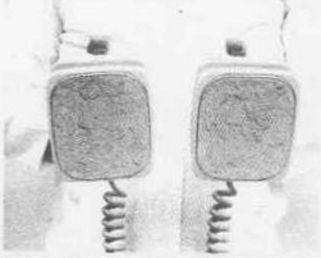
- Apply a liberal amount of Redux® paste (P/N 651-1008) to the electrode surface of each paddle.

WARNINGS

Handguards around the paddles prevent shock to the operator. TO AVOID RISK OF ELECTRICAL SHOCK TO THE OPERATOR DURING DISCHARGE, DO NOT ALLOW PASTE TO ACCUMULATE ON THE HANDS OR THE PADDLE HANDLES.

Do not use Redux gel (P/N 651-1024) on defibrillator paddles.

- Gently rub the electrode surfaces together to evenly distribute the applied paste.



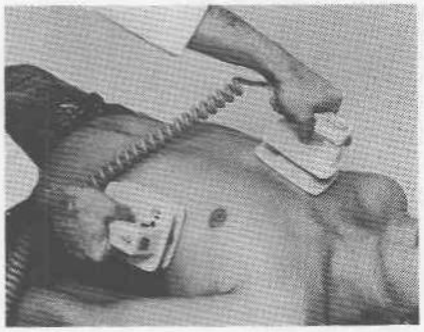
APPLY PADDLES TO CHEST

- Apply the paddles firmly to the anterior wall of the chest. The STERNUM paddle should be placed to the right of the sternum just below the clavicle; the APEX paddle should be placed on the chest wall, just below and to the left of the left nipple, in the anterior-axillary line.
- Rub the paddles slightly against the skin to maximize the paddle-to-patient contact.

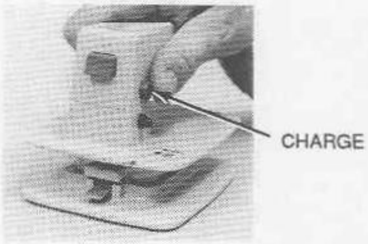
WARNING

DO NOT ALLOW PASTE TO ACCUMULATE BETWEEN THE PADDLE ELECTRODES ON THE CHEST WALL AS THIS COULD CAUSE BURNS.

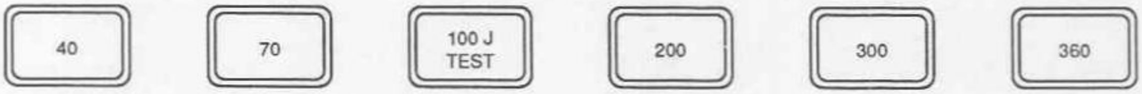
- If PADDLES ECG is used, keep the paddles still to minimize motion artifact on the monitor.
- Recommended applied pressure is 10-12 kg (22-25 lbs) per paddle.



CHARGE DEFIBRILLATOR MODULE



- If 200 Joules is desired, press the Apex paddle CHARGE button.
- If a different setting is needed, press the correct Defibrillator module control panel ENERGY SELECT/CHARGE key.



NOTES

For subsequent discharges, the Apex paddle CHARGE button will initiate charging to the most recently selected energy level.

Pressing a charge switch will initiate an automatic stripchart recorder run and will automatically annotate a CHARGE message.

- When charging is completed a tone will sound, the CHARGE DONE INDICATOR on the Apex paddle will light, and the ENERGY-JOULES display will indicate the available energy.

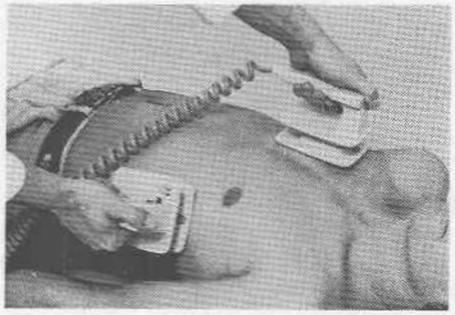
NOTES

To Disarm a charged defibrillator if a countershock is not needed, press the ON/DISARM key.

- As a safety feature, the Defibrillator module will internally dump the selected energy if not discharged within 60 seconds. The steady tone will change to a beep 10 seconds before this occurs. The RECORDER will automatically annotate the message DISARM if this occurs.
- To change a selected energy level at any time, press the desired ENERGY SELECT/CHARGE key and wait for the steady tone to sound.

DISCHARGE

- Verify that no one is in contact with the patient, monitoring cable or leads, bed rails, or any other potential current pathway.
- Call out "CLEAR" to alert other personnel to stand clear of the patient.
- Press and briefly hold both DISCHARGE buttons (one on each paddle) simultaneously, to deliver energy to the patient.



NOTES

The stripchart recorder will stop automatically 10 seconds after discharge and will automatically annotate a DISCHARGE message.

The ECG MEMORY will record session (if less than 30 minutes).

If the defibrillator does not discharge, press the CHARGE button again, wait for the steady tone, and press the DISCHARGE buttons again. If it still will not discharge, press the POWER OFF/RECHARGE button, and use a back-up defibrillator. Alert appropriate service personnel as soon as possible, and save any generated recorder strips for later evaluation.

AFTER USE

- Press both the Defibrillator and Monitor-Recorder POWER OFF/RECHARGE keys.
- Return the instrument to its storage location, and plug the power cord into an AC power outlet. Verify that the BATTERY CHARGE indicators on both modules light.
- Clean all paddles, controls, and cables as necessary.
- Check that adequate recorder paper and electrolyte paste are available for the next use.

The Monitor-Recorder module can be used for either short-term or long-term cardiac monitoring. A fully charged battery pack provides a minimum of 4 hours of continuous monitoring. The power cord may be connected to AC power at any time for indefinite periods of monitoring.

The Monitor-Recorder module has built-in protection circuitry to allow patient monitoring to continue during a defibrillation attempt. Monitoring electrodes may become polarized during defibrillation discharge, causing the ECG waveform to briefly disappear from the display. The use of silver-silver chloride electrodes will minimize this effect, and circuitry in the unit will return the trace to the monitor display within a few seconds.

ECG monitoring may be accomplished through the paddle electrodes, however this is typically done only for emergency evaluation of patient condition, when electrode leads are not attached to the patient. Note that the Defibrillator module power must be on to monitor ECG through the paddles. Paddles as the ECG SOURCE is NOT recommended for use during elective cardioversion procedures with the instrument in synchronous (SYNC) mode. (See section 5 for detailed information on Elective Cardioversion.)

PREPARATION FOR ECG MONITORING

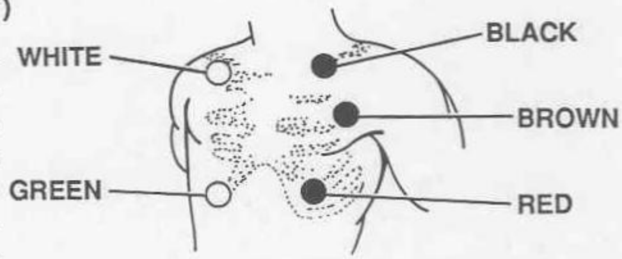
Proper application and placement of electrodes is essential for quality ECG monitoring. Good contact between the electrode and skin minimizes the effects of motion artifact and signal interference.

FIVE-LEAD CABLE ELECTRODE PLACEMENT

RA/White electrode:	Place near right midclavicular line, directly below clavicle.
LA/Black electrode:	Place near left midclavicular line, directly below clavicle.
LL/Red electrode:	Place between 6th and 7th intercostal space on left midclavicular line.
RL/Green electrode:	Place between 6th and 7th intercostal space on right midclavicular line.
C/Brown electrode:	Chest or V position (V1 - V6).

LEAD CONFIGURATION

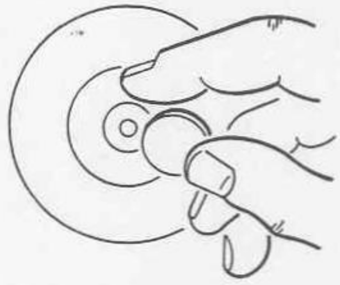
LEAD	(+)	(−)	(ref)
I	LA	RA	RL
II	LL	RA	RL
III	LL	LA	RL
aVR	RA	(LA+LL)÷2	RL
aVL	LA	(RA+LL)÷2	RL
aVF	LL	(RA+LA)÷2	RL
V	C	(RA+LA+LL)÷3	RL



If necessary, shave hair from application site to ensure good electrode to skin contact. Cleaning the skin with soap and water and/or alcohol, and wiping dry is also helpful.

ATTACHING DISPOSABLE ELECTRODES

- Peel the protective backing from the electrode. Be careful to keep adhesive surface free from electrolyte paste.
- Apply the electrodes firmly to the patient's skin, pressing around the entire perimeter of the electrode.
- Attach snap-on, assuring good contact between the electrode and the lead termination. Tape the lead wire to nearby skin to avoid loosening of the electrode and/or lead.



- Plug the patient cable connector into the electrode lead connector (located on front right of instrument, recessed in the storage pocket).

SETTING THE CONTROLS

Press the Monitor-Recorder module POWER ON key. Verify all indicators light and a tone sounds for one second. Verify the CRT screen display flashes "READY", and displays "NO DEFIB", "O P" and a moving trace.

- Press the LEAD SELECT key until the desired lead (I, II, III, aVR, aVL, aVF, or V) is selected (displayed on the CRT screen).

NOTE

If paddles are used as the ECG SOURCE, press Defibrillator module POWER ON key. Verify Monitor-Recorder "NO DEFIB" message is no longer displayed on the CRT. Press PADDLES key and verify the CRT displays a "P". Use paddles as ECG SOURCE.

Adjust the following controls as required.

- BEEPER volume. Defaults to mid-range. Use SELECT key and UP or DOWN arrow keys to adjust volume to desired level.
- ECG SIZE. Defaults to AUTOGAIN (size automatically adjusted to detect ECG R wave). Use SELECT key and UP or DOWN arrow keys to adjust ECG SIZE to desired level.
- Heart Rate ALARM. Defaults to ALARMS OFF with rates preset to 40 bpm (LO) and 140 bpm (HI). Use SELECT key and UP or DOWN arrow keys to adjust LO and HI ALARM rates to desired level. TO activate Heart Rate Alarms, press the ALARMS ON/OFF key until ALARMS OFF indicator is off.
- ECG MEMORY. Defaults 25 minutes post-alarm and 5 minutes pre-alarm time and begins RECording when power is turned ON. Use MODE key to select:

  STOP mode to end recording or playback.

  PLAY mode to view recorded material.

  SET mode to change post alarm settings.

  REC mode to resume recording.

Certain arrhythmias require synchronizing defibrillator discharge with the ECG R wave to avoid inducing ventricular fibrillation. This capability is provided with the Defibrillator/Monitor-Recorder by using SYNC mode. When the paddle discharge buttons are pressed in SYNC mode, the unit will discharge on the next detected R wave, thus avoiding the vulnerable T wave segment of the cardiac cycle.

When the Defibrillator/Monitor-Recorder is in SYNC mode for synchronized cardioversion, a marker pulse is superimposed on the ECG as it appears on the CRT screen to indicate the point in the cardiac cycle where the discharge will occur. This marker appears as a bright dot on the ECG waveform on the CRT screen, and a short line in the margin of the recorder strip above the ECG waveform.

PATIENT PREPARATION

- Prepare patient as described in Section 4, ECG Monitoring.

ATTACHING DISPOSABLE ELECTRODES

- Connect leads as described in Section 4, ECG Monitoring.

SETTING THE CONTROLS

- Press the Monitor-Recorder module POWER ON key. Verify all indicators light and a tone sounds for one second. Verify the CRT screen displays flashes "READY", and displays "0 P" and a moving trace.
- Press the Defibrillator module POWER ON key. Verify all indicators light and a tone sounds for one second. Verify the ENERGY-JOULES display flashes "HP" and "888", then displays "0".
- Press the Monitor-Recorder module ECG SELECT key until the desired lead is displayed on the CRT screen. (Lead II usually yields the best ECG for R wave detection.)
- Press **both** Defibrillator module SYNC keys simultaneously and verify the SYNC indicator lights and the Monitor-Recorder module displays "SYNC" on the CRT screen.

NOTES

If PADDLES are selected as the ECG source, the Monitor-Recorder will flash the message "USE LEADS" to remind the operator that recommended procedure is to ***USE LEADS DURING SYNC MODE.*** *In either case, the ECG source must be properly attached to the patient, or incorrect ECG data may be obtained resulting in improper operation.*

Verify that the Monitor is displaying real time and not recorded information. The CRT screen should display SYNC (not PLAYBACK) in the lower left corner, and the ECG MEMORY indicator should be on REC, STOP, or SET.

SETTING THE CONTROLS — Continued

- Always inspect the displayed ECG before delivering the countershock. Verify that a marker pulse (indicating discharge point) appears only with each R wave. The marker pulse is a bright dot on the CRT screen or a short line in the margin of the recorder strip. In addition, the SYNC indicator on the Defibrillator module will blink off with each detected R wave.

  Should a marker pulse not appear, or if a marker pulse is viewed on the T wave segment of the ECG:

  1. Press SELECT key until ECG SIZE indicator lights, and use UP/DOWN ARROW keys to adjust the ECG SIZE until the marker pulse appears only with each R wave.
  2. Select a different lead or adjust electrode placement to improve ECG R wave quality.
  3. If the indication is still incorrect, do not use the instrument for synchronized cardioversion.

VERIFY DEFIBRILLATOR OPERATION BEFORE PROCEEDING

Perform the following brief test to ensure proper defibrillator performance:

- Verify that the adult paddle electrodes are installed.
- Leaving the paddles in their holders, press the ENERGY SELECT/CHARGE 100 J/TEST key. Wait for the steady tone to sound and the energy display to indicate "100" Joules.
- With the paddles pressed firmly into their holders, press and hold both discharge buttons simultaneously. Verify the defibrillator discharges with the next detected R-wave and the neon TEST light located in the storage pocket between the two paddles flashes.

PREPARE PADDLES

- Remove the paddles from their holders.
- Apply a liberal amount of Redux® paste (P/N 651-1008) to the electrode surface of each paddle.

WARNING

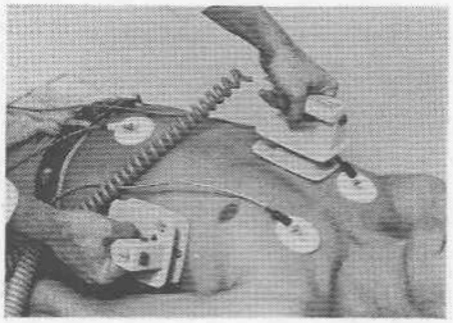
Handguards around the paddles prevent shock to the operator. TO AVOID RISK OF ELECTRICAL SHOCK TO THE OPERATOR DURING DISCHARGE, DO NOT ALLOW PASTE TO ACCUMULATE ON THE HANDS OR THE PADDLE HANDLES.

Do not use Redux gel (P/N 651-1024) on defibrillator paddles.

- Gently rub the electrode surfaces together to evenly distribute the applied paste.

APPLY PADDLES TO CHEST

- Apply the paddles firmly to the anterior wall of the chest. The STERNUM paddle should be placed to the right of the sternum just below the clavicle; the APEX paddle should be placed on the chest wall, just below and to the left of the left nipple, in the anterior-axillary line.



- Rub the paddles slightly against the skin to maximize the paddle-to-patient contact.

WARNING

DO NOT ALLOW PASTE TO ACCUMULATE BETWEEN THE PADDLE ELECTRODES ON THE CHEST WALL AS THIS COULD CAUSE BURNS.

- If PADDLES are used as the ECG signal source, keep them as still as possible to minimize motion artifact.

NOTE

Use of the patient cable is recommended to avoid unintended synchronization on paddle motion artifact. In either case, the ECG source must be properly attached to the patient, or incorrect ECG data may be obtained resulting in improper operation.

- Recommended applied pressure is 10-12 kg (22-25 lbs) per paddle.

CHARGE DEFIBRILLATOR MODULE

- If 200 Joules is desired, press the Apex paddle CHARGE button. If a different setting is needed, press the correct Defibrillator module control panel ENERGY SELECT/CHARGE key.

NOTES

For subsequent discharges, the Apex paddle CHARGE button will initiate charging to the most recently selected energy level.

Pressing a charge switch will initiate an automatic stripchart recorder run and will automatically annotate a CHARGE message.

- When charging is completed a tone will sound, the CHARGE DONE INDICATOR on the Apex paddle will light, and the ENERGY-JOULES display will indicate the available energy.

NOTE

To Disarm a charged defibrillator if a countershock is not needed, press the ON/DISARM key.

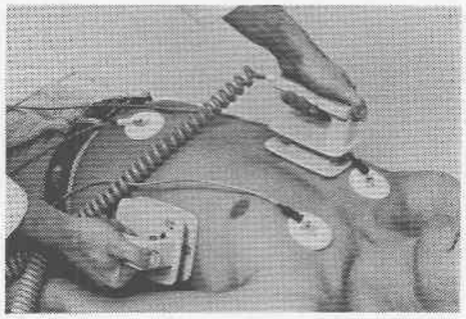
- As a safety feature, the Defibrillator module will internally dump the selected energy if not discharged within 60 seconds. The steady tone will change to a beep 10 seconds before this occurs. The RECORDER will automatically annotate the message DISARM if this occurs.
- To change a selected energy level at any time, press the desired ENERGY SELECT/CHARGE key and wait for the steady tone to sound.

DISCHARGE

- Verify that the ECG waveform is stable, and that a marker pulse appears ONLY with each R wave of the cardiac cycle.
- Verify that no one is in contact with the patient, monitoring cable or leads, bed rails, or any other potential current pathway.
- Call out "CLEAR" to alert other personnel to stand clear of the patient.
- Press and hold both DISCHARGE buttons (one on each paddle) simultaneously. Energy will be delivered to the patient on the next detected R-wave.

NOTE

If SYNC is lost before discharge occurs, the CRT screen will display SYNC LOST and the defibrillator will discharge internally.



- If additional countershocks are required, re-select SYNC mode and ENERGY level as necessary, and repeat the above procedure.

NOTES

The stripchart recorder will stop automatically 10 seconds after discharge and will automatically annotate a DISCHARGE message.

The ECG MEMORY will record session (if less than 30 minutes).

If the defibrillator does not discharge, press the CHARGE button again, wait for the steady tone, and press the DISCHARGE buttons again. If it still will not discharge, press the POWER OFF/RECHARGE button, and use a back-up defibrillator. Alert appropriate service personnel as soon as possible, and save any generated recorder strips for later evaluation.

AFTER USE

- Press both the Defibrillator and Monitor-Recorder POWER OFF/RECHARGE keys.
- Return the instrument to its storage location, and plug the power cord into an AC power outlet. Verify that the BATTERY CHARGE indicators on both modules light.
- Clean all paddles, controls, and cables as necessary.
- Check that adequate recorder paper and electrolyte paste are available for the next use.

MONITOR-RECORDER MODULE CHECKS

- Press the POWER OFF/RECHARGE key. Plug the AC power cord into an available AC power outlet. Verify that the BATT CHRG indicator lights. Unplug the AC power cord.
- Press the POWER ON key, and verify that all indicators (except BATT CHRG) light and a tone sounds for about one second, and the CRT momentarily displays "READY". Verify that the BEEPER, ALARMS OFF, and REC indicators are on, and that the CRT screen displays "0 P" and a moving trace.

NOTE

If the Defibrillator module is not connected or turned off, the CRT screen will also display "NO DEFIB".

- After a flat ECG signal has been present on the CRT display for four seconds, press the ALARMS ON/OFF key until the ALARMS OFF indicator turns off. Verify that with a flat ECG signal, the alarm tone sounds within four seconds and the stripchart recorder starts and prints "ALARM" in the margin.
- Press ALARMS ON/OFF key and verify the ALARMS OFF indicator turns on and the alarm tone quits. After approximately 10 seconds, verify, the stripchart recorder stops.
- Press the ECG SOURCE LEAD SELECT key as required, and verify that the CRT screen displays "II, III, aVR, aVL, aVF, V, and I".
- Press the PADDLES key and verify the CRT screen displays "P".

NOTE

If the Defibrillator module is not connected or turned off, the Monitor-Recorder CRT screen will display "NO DEFIB".

- Press the SELECT key until the HI ALARM indicator lights. Verify the CRT displays 40 and 140 with the 140 flashing. Use UP/DOWN arrows and verify the 140 increases and decreases. Reset to 140.
- Press the SELECT key until the LO ALARM indicator lights. Verify the CRT displays 40 and 140 with the 40 flashing. Use the UP/DOWN arrows and verify the 40 increases and decreases. Reset to 40. Press the SELECT key until the BEEPER indicator lights.
- Press the RUN/STOP key and verify the stripchart recorder starts. Verify the ECG wave is the same as on the CRT screen, and that the margin annotates heart rate (HR 0), ECG source (PADDLES), and ECG gain (AUTOGAIN 40 mm/mV).
- Press the 1mV CAL key and verify that a pulse is generated on both the CRT and stripchart recorder. Press the RUN/STOP key and verify the stripchart recorder stops.
- Press the ECG MEMORY MODE key until the PLAY indicator lights. Verify that the message "PLAYBACK" appears on the CRT screen. Use the LEFT and RIGHT ARROW button to scan through ECG memory and find the messages "PLAY BEGIN", "PLAY ALARM", and "PLAY END".
- Press the ECG MEMORY MODE key until the STOP indicator lights and verify the CRT screen momentarily displays "STOP".

MONITOR-RECORDER MODULE CHECKS — Continued

- Press the SELECT key until the BEEPER indicator lights. Press and hold both the UP and DOWN arrow keys and verify the CRT screen displays battery voltage between 11.2- 14.3 volts nominally.
- Verify that there are adequate accessories (lead set, paper, gel, electrodes, etc) stored with the instrument.

DEFIBRILLATOR MODULE CHECKS

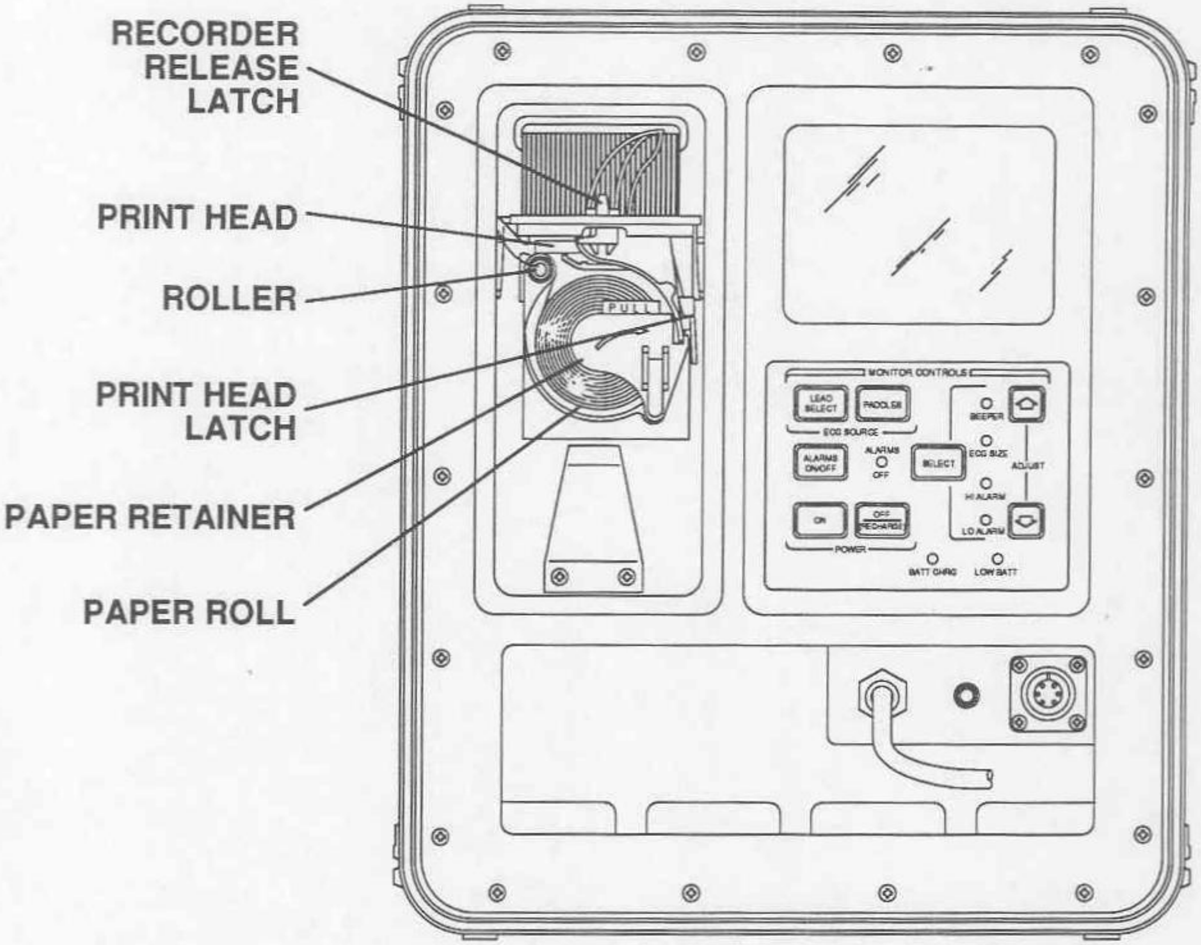
- Press the POWER OFF/RECHARGE key. Plug the AC power cord into an available AC power outlet. Verify that the BATTERY CHARGE indicator lights. Unplug the AC power cord.
- Press the POWER ON/DISARM key, and verify that all indicators (except BATTERY CHARGE) light and a tone sounds for about one second, and the ENERGY-JOULES display alternately flashes "HP" and "888", then displays "0".
- Press both SYNC keys simultaneously and verify the SYNC indicator lights, and "SYNC" - "USE LEADS" is displayed on the Monitor-Recorder module CRT screen.
- Press both SYNC keys again and verify the SYNC indicator goes out and the Recorder module CRT screen no longer displays "SYNC".

NOTE

If a Monitor-Recorder is not properly connected or turned on, SYNC indicator will flash once and the ENERGY-JOULES display will flash "EEE".

- Verify that the adult paddle electrodes are installed.
- Leaving the paddles in their holders, press the ENERGY SELECT/CHARGE 100J/TEST key. Verify the ENERGY-JOULES display starts counting and the Monitor-Recorder stripchart recorder starts and prints "CHARGE" in the margin. Wait for the steady tone to sound and verify the ENERGY-JOULES display indicates "100".
- With the paddles pressed firmly into their holders, simultaneously press and briefly hold both discharge buttons. Verify the neon TEST light flashes, the ENERGY-JOULES display indicates "0". and stripchart recorder prints "DISCHARGE" in the margin.
- Press the ENERGY SELECT/CHARGE 40 key and wait for the steady tone. Verify the ENERGY-JOULES display starts counting and the Monitor-Recorder stripchart recorder starts and prints "CHARGE" in the margin. Wait for the steady tone to sound and verify the ENERGY-JOULES display indicates "40".
- Press the ON/DISARM key and verify the ENERGY-JOULES display starts counting back to 0 and the Monitor-Recorder stripchart recorder prints "DISARM" in the margin.
- Press and hold the ON/DISARM and the right-hand SYNC keys and verify the ENERGY-JOULES display indicates battery voltage between 11.2-14.3 volts nominally.
- Press the Defibrillator and Monitor-Recorder modules POWER OFF/RECHARGE keys.

CHANGING RECORDER PAPER


RECORDER RELEASE LATCH
PRINT HEAD
ROLLER
PRINT HEAD LATCH
PAPER RETAINER
PAPER ROLL
PULL
MONITOR CONTROLS
LEAD SELECT
PADDLES
ECG SOURCE
ALARMS ON/OFF
ALARMS OFF
SELECT
BEEPER
ECG SIZE
HI ALARM
LO ALARM
ADJUST
ON
OFF RECHARGE
POWER
BATT CHRG
LOW BATT

- Press the Monitor-Recorder module POWER OFF/RECHARGE key.
- Turn the recorder release latch and lift the recorder mechanism to its fully open, latched position (as illustrated).
- Pull down on the printhead latch (right side) mechanism until it locks in the unloaded position (down).
- Grasp and pull the paper retainer toward you and rotate it out of the way.
- Remove the empty or low paper roll from the spindle.
- Place a new roll of thermal paper (one roll of HP part number 40453A) on the spindle with the paper wound clockwise and feed between the roller and printhead (paper grid faces up).
- Rotate the paper retainer until it is centered over the paper spool and spindle and allow it to fall into position over the paper spool.
- Unlock the printhead mechanism back on to the paper and roller.
- Close the recorder door and turn the recorder door latch.

CLEANING THE RECORDER PRINTHEAD

The printhead should be cleaned after every three months of use, or when a buildup of carbon residue becomes excessive and causes poor print quality. If the print is light overall, also check that the proper paper is being used (HP 40453A).

- Open the recorder by turning the recorder release latch. Raise the recorder fully to allow access to the printhead.
- Pull down on the back of the printhead assembly to lock the printhead away from the roller and remove the paper roll.
- Dampen a cotton swab in alcohol and wipe the area of the printhead just above the roller until the carbon residue has been removed.
- Reinstall the paper roll and close the recorder door.

CLEANING EXTERIOR SURFACES

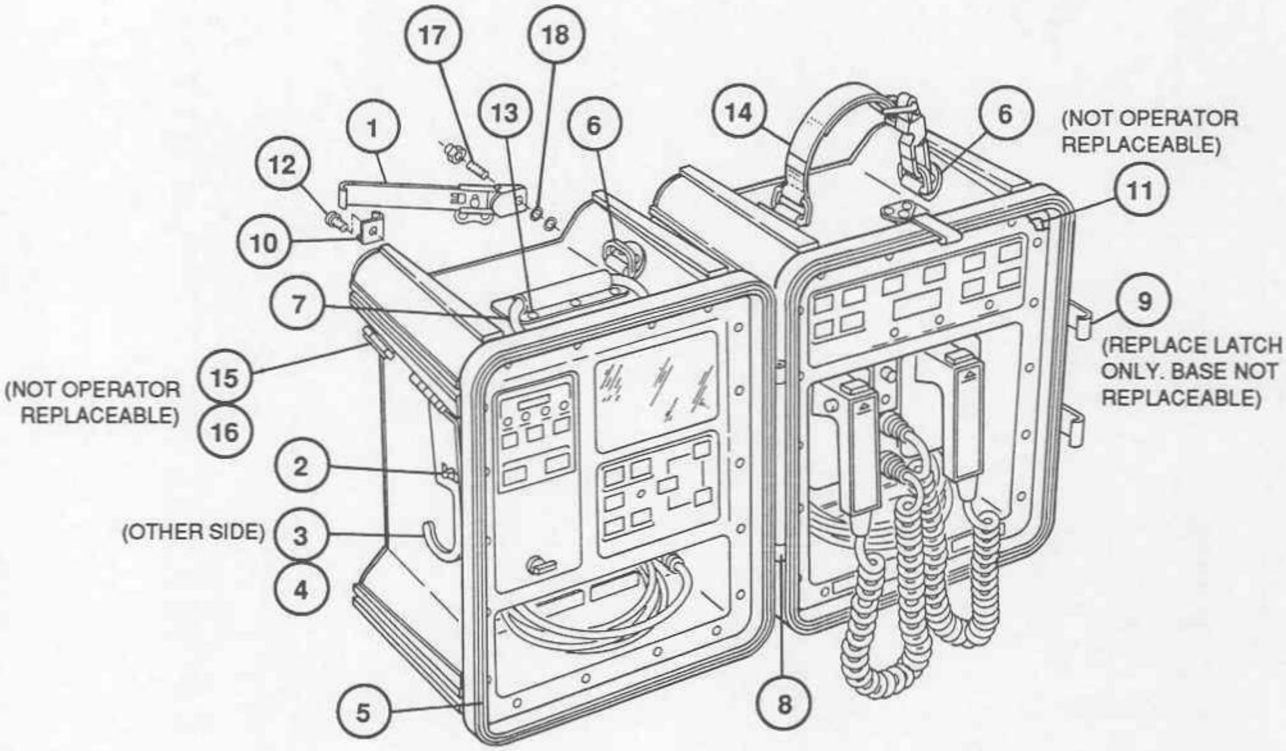
- The Defibrillator/Monitor-Recorder and its accessories are chemically resistant to common hospital cleaning solutions and non-caustic detergents. Some approved cleaning solutions are:
  - Alcohol
  - Soap and water
  - Chlorine bleach (30ml/l water)
  - Ammonia-based household cleaners
- Keep the outside surface of the instrument clean and free of dust and dirt. Clean paddles thoroughly to prevent build-up of dried electrolyte.
- DO NOT allow any fluids to penetrate the instrument case, and avoid pouring fluid on the unit while cleaning.
- DO NOT use abrasive cleaners (i.e. steel wool, silver polish), or strong solvents such as acetone, or acetone-based compounds.
- Use care in cleaning the monitor screen; it is especially sensitive to rough handling and subject to scratching.
- DO NOT steam sterilize the monitoring leads, submerge them for prolonged periods, or heat them above 50°C. If metallic surfaces become oxidized, clean them with a very light abrasive (toothpaste works well.) DO NOT use highly abrasive cleaners (i.e. steel wool, silver polish).

REPLACING THE BATTERY ASSEMBLY

Installing or replacing a battery assembly requires that the modules be removed from the case. Refer the equipment to an appropriately trained service person if low battery capacity is suspected.

REPLACING THE CASE HARDWARE

All case hardware except the pressure relief value and panel gaskets can be replaced by the operator. Because the modules must be removed from the case, refer replacement of the pressure relief value and panel gaskets to an appropriately trained service person.


17
18
1
13
6
12
10
7
(NOT OPERATOR REPLACEABLE)
15
16
2
(OTHER SIDE) 3
4
5
14
6
(NOT OPERATOR REPLACEABLE)
11
9
(REPLACE LATCH ONLY. BASE NOT REPLACEABLE)
8

- Press the Defibrillator and Monitor-Recorder Modules POWER OFF/RECHARGE keys.
- All items removable with pozidrive screwdriver, nutdriver, and pliers. When replacing hardware torque as follows: Ball Studs (2) to 8-inch/lbs, No. 8 Screws to 12-inch/lbs, and the locknut to 10 to 12-inch/lbs.
- When removing Latch Q.T.Assembly (9), compress springs with pliers and remove. Only replaceable part is latch (base is not replaceable). Reposition new latch and replace springs.
- Monitor Cover Assembly (HP P/N 43201-60306) is not shown, but contains 1 EA item 7, 1 EA item 8, and 4 EA item 9.

43110MC Replaceable Case Parts

ITEM	DESCRIPTION	HP PART NUMBER	QTY
1	Back Latch Q.T.	43201-07502	1
2	Ball Stud	0510-1338	2
3	Bed Mount, Left	43201-07312	1
4	Bed Mount, Right	43201-07311	1
5	Case Gasket (53")	43201-07904	1
6	D Ring & Anchor	43201-47206	2
7	Handle	43201-07317	5
8	Hinge Assembly	43201-07401	1
9	Latch Q.T.Assembly	43201-07501	8
10	Latch Strike	43201-07500	2
11	Panel Gasket (13")	43201-07905	2
12	Screw,Machine 8-32 x 0.312	2510-0043	9
13	Screw,Machine 8-32 x 0.375	2510-0045	26
14	Strap Assembly	43201-67104	1
15	Valve Auto	43201-27900	1
16	Valve Cover	43201-47315	1
17	Stud, Threaded	43131-27302	1
18	Step Washer	43131-27303	1

These checks are intended to briefly verify proper operation of the Defibrillator and Monitor-Recorder modules. A test routine incorporating these checks along with visual inspection for mechanical integrity of all cables, paddles, and controls should be performed regularly as indicated.

EVERY SHIFT

DEFIBRILLATOR MODULE

- With the unit connected to AC power, verify the "BATTERY CHARGE" indicator is on.
- Check for adult or defibrillator electrodes.

MONITOR-RECORDER MODULE

- With the unit connected to AC power, verify the "BATT CHRG" indicator is on.
- Check for adequate thermal paper in the stripchart recorder.
- Check for presence of ECG leads, electrodes, and adequate Redux® electrolyte paste (P/N 651-1008).

EVERY WEEK

DEFIBRILLATOR MODULE

- Verify that the adult paddle electrodes are installed.
- Press the POWER OFF/RECHARGE key. Plug the AC power cord into an available AC power outlet. Verify that the BATTERY CHARGE indicator lights. Unplug the AC power cord.
- Press the POWER ON/DISARM key, and verify that all indicators (except BATTERY CHARGE) light and a tone sounds for about one second, and the ENERGY-JOULES display alternately flashes "HP" and "888", then displays "0".
- Leaving the paddles in their holders, press the ENERGY SELECT/CHARGE 100J/TEST key. Verify the ENERGY-JOULES display starts counting. Wait for the steady tone to sound and verify the ENERGY-JOULES display indicates "100".

NOTE

If the Monitor-Recorder module is connected and turned on, the stripchart recorder will start and print "CHARGE" in the margin.

EVERY WEEK — Continued

DEFIBRILLATOR MODULE — Continued

- With the paddles pressed firmly into their holders, simultaneously press and briefly hold both discharge buttons. Verify the neon TEST light flashes and the ENERGY-JOULES display indicates "0".

NOTES

If the Monitor-Recorder module is connected and turned on, the stripchart recorder will print "DISCHARGE" in the margin.

Failure to light the 100J test light may indicate that the defibrillator output is not capable of delivering the selected level to the patient.

- Repeat test with the paddle cables fully extended to verify the cables do not have broken wires or contacts.
- If any of the above steps are incorrect, notify service personnel.

NOTE

The above tests are no substitute to testing output levels using a calibrated energy measuring device. This instrument should be tested periodically to ensure the output is within specified limits (see service manual).

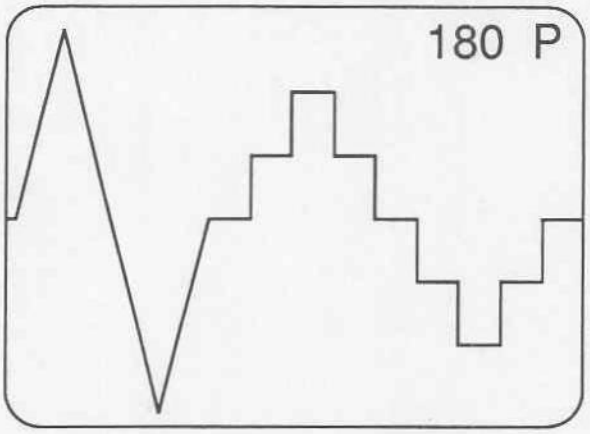
EVERY WEEK — Continued

MONITOR-RECORDER MODULE

- Press the POWER OFF/RECHARGE key. Plug the AC power cord into an available AC power outlet. Verify that the BATT CHRG indicator lights. Unplug the AC power cord.
- Press and hold LEFT and RIGHT arrow keys. While holding both arrow keys, press the POWER ON key, then immediately press the SELECT key. Verify that all indicators (except BATT CHRG) light and a tone sounds for about one second, and the CRT momentarily displays "READY". Verify that the BEEPER, ALARMS OFF, and REC indicators are on, and that the CRT screen is as shown below.

NOTE

If the Defibrillator module is not connected or turned off, the CRT screen will also display "NO DEFIB".



- The Monitor-Recorder module is now in test mode. Verify that the triangle waveform extends to within 1 cm of the top and bottom edges of the CRT screen.

NOTE

Do not press the UP and DOWN ARROW keys simultaneously while in the Test Mode, as this will remove the test waveform and disable the normal operating messages.

- Press the RUN/STOP key and verify that printer starts and prints the waveform displayed on the CRT screen. Inspect the recorder waveform for uniformity and darkness. Press the RUN/STOP key again and verify that printer stops.
- Press the MODE key until the PLAY indicator lights. Verify that the message "PLAYBACK" appears on the CRT screen and that the same waveform is displayed.

EVERY WEEK — Continued

MONITOR-RECORDER MODULE — Continued

- Press the POWER OFF/RECHARGE key, then the POWER ON key. Verify that all indicators (except BATT CHRG) light and a tone sounds for about one second, and the CRT momentarily displays "READY". Verify that the BEEPER, ALARMS OFF, and REC indicators are on.

NOTE

If the Defibrillator module is not connected or turned off, the CRT screen will also display "NO DEFIB".

- Press the ALARMS ON/OFF key until the ALARMS OFF indicator turns off. Verify that with a flat ECG signal, the alarm tone sounds within four seconds and the stripchart recorder starts and prints "ALARM" in the margin.
- Press ALARMS ON/OFF key and verify the ALARMS OFF indicator turns on and the alarm tone quits. After approximately 10 seconds, verify, the stripchart recorder stops.
- If any of the above steps are incorrect, notify service personnel.

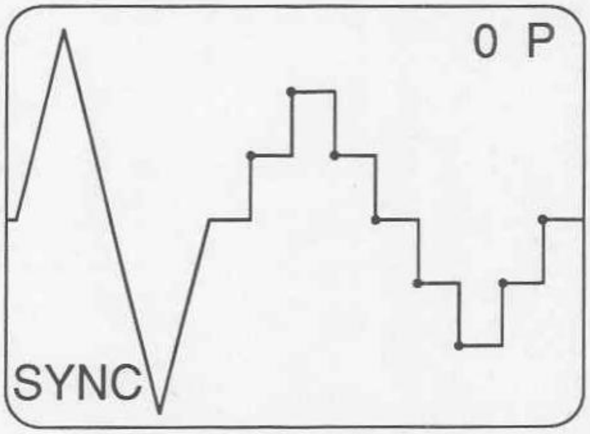
DEFIBRILLATOR/MONITOR-RECORDER SYSTEM

- Perform ALL the Defibrillator module and Monitor-Recorder module checks above.
- Press the Defibrillator module POWER OFF/RECHARGE key, then press the POWER ON/DISARM key. Verify that all indicators (except BATTERY CHARGE) light and a tone sounds for about one second, and the ENERGY-JOULES display alternately flashes "HP" and "888", then displays "0".
- Press the Monitor-Recorder module POWER OFF/RECHARGE key. Press and hold the LEFT and RIGHT arrow keys. While holding both arrow keys, press the POWER ON key, then immediately press the SELECT key. Verify that all indicators (except BATT CHRG) light and a tone sounds for about one second, and the CRT momentarily displays "READY". Verify that the BEEPER, ALARMS OFF, and REC indicators are on.

EVERY WEEK — Continued

DEFIBRILLATOR/MONITOR-RECORDER SYSTEM — Continued

- Press both Defibrillator module SYNC keys simultaneously and verify the SYNC indicator lights, and "SYNC" - "USE LEADS" is displayed on the Monitor-Recorder module CRT screen. Verify the CRT screen displayed waveform is as shown below with sync markers (dots) at each "step" in the step waveform.



- Press the Monitor-Recorder module RUN/STOP key and verify that printer starts and prints the waveform displayed on the CRT screen. Inspect the recorder waveform for uniformity and darkness and verify that a sync marker (line) appears above each "step" in the step waveform. Press the RUN/STOP key again and verify that printer stops.

NOTES

It is normal for the ramp portion of the waveform to be clipped on the top and bottom of the printed output.

It is normal for the vertical portion of the step waveform to be missing when it coincides exactly with the sync marker on the top margin of the printed output.

- Press the Monitor-Recorder module POWER OFF/RECHARGE key.
- Press the Defibrillator module POWER OFF/RECHARGE key.

For more information, call your local HP office or East (301) 948-6370 Midwest (312) 255-9800 South (404) 955-1500 West (213) 877-1282; or write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, Hewlett-Packard S.A., 7, rue du Bois-du-lan, P. O. Box CH-1217, Meyrin 2, Geneva, Switzerland. In Japan, Yokogawa-Hewlett-Packard Ltd., 29-21, Takaido-Higashi 3-chome, Suginami-ku, Tokyo 168.

HEWLETT
PACKARD

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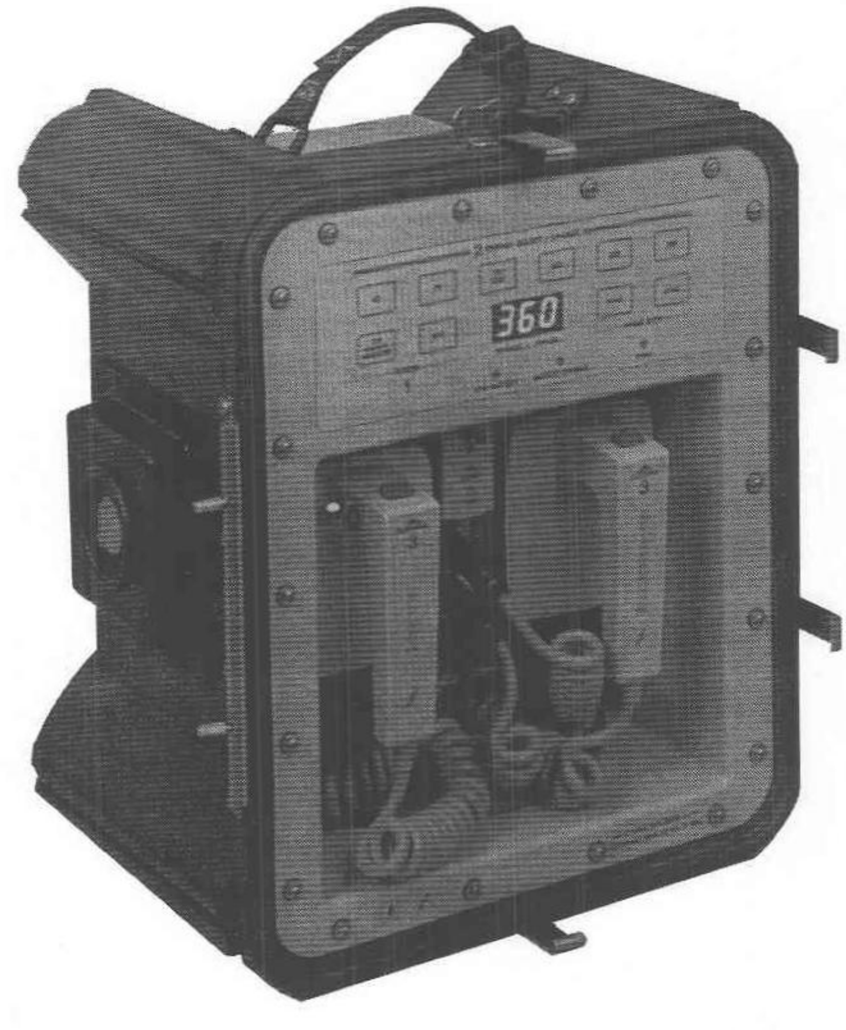
43130M
DEFIBRILLATOR MODULE



SERVICE MANUAL

HEWLETT
PACKARD

43130M
DEFIBRILLATOR MODULE

SERVICE MANUAL

PART NUMBER 43131-91909

This manual applies to instruments with
serial number prefix through 2943A.

Second Edition

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WARRANTY

Hewlett-Packard (HP) warrants this medical product against defects in materials and workmanship for a period of one (1) year from the date of shipment.

If HP receives notices of such defects during the warranty period, HP shall at its option either repair or replace hardware products which prove to be defective.

PLACE OF PERFORMANCE

Defective hardware is to be shipped, freight prepaid, to:

Hewlett-Packard Company, McMinnville Division
1700 S. Baker St.
McMinnville, Oregon 97128

Attention DEPMEDS Warranty Services, Return Authorization #30001484

All warranty repairs will be performed by HP or by a subcontractor authorized by HP to act in its behalf.

Repaired hardware will be shipped, freight prepaid, to the specified CONUS location.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from:

- Improper or inadequate maintenance by users,
- Unauthorized modification or misuse, or
- Operation outside of the environmental specification for the product.

THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

LIMITATION OF REMEDIES AND LIABILITY

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES IN NO EVENT SHALL HP BE LIABLE FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING LOSS OF PROFITS) WHETHER BASED ON CONTRACT, TORT OR ANY OTHER LEGAL THEORY.

The foregoing limitation of liability shall not apply in the event that any HP product sold hereunder is determined by a court of competent jurisdiction to be defective and to have directly caused bodily injury, death or property damage; provided, that in no event shall HP's liability for property damage exceed the greater of $50,000 or the purchase price of the specific product that caused such damage.

SAFETY

GENERAL

This module and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the main power source to the individual instruments input wiring terminals, power cord, or supplied power cord set.

WARNINGS

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.) In addition, verify that a common ground exists between the unit under test and this instrument prior to energizing either unit.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the mains supply).

Servicing instruction are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

For continued protection against fire hazard, replace the fuse(s) only with with 250V fuse(s) of the same current rating and type (for example, normal blow time, time delay, etc.). Do not use repaired fuses or short circuited fuseholders.

SAFETY SYMBOLS

⚠ Instruction manual symbol: The individual system instruments will be marked with this symbol when it is necessary for the user to refer to the instruction manual (see Table of Contents for page references).

⚡ Indicates hazardous voltages.

⏚ Indicates earth (ground) terminal.

WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the system instruments. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

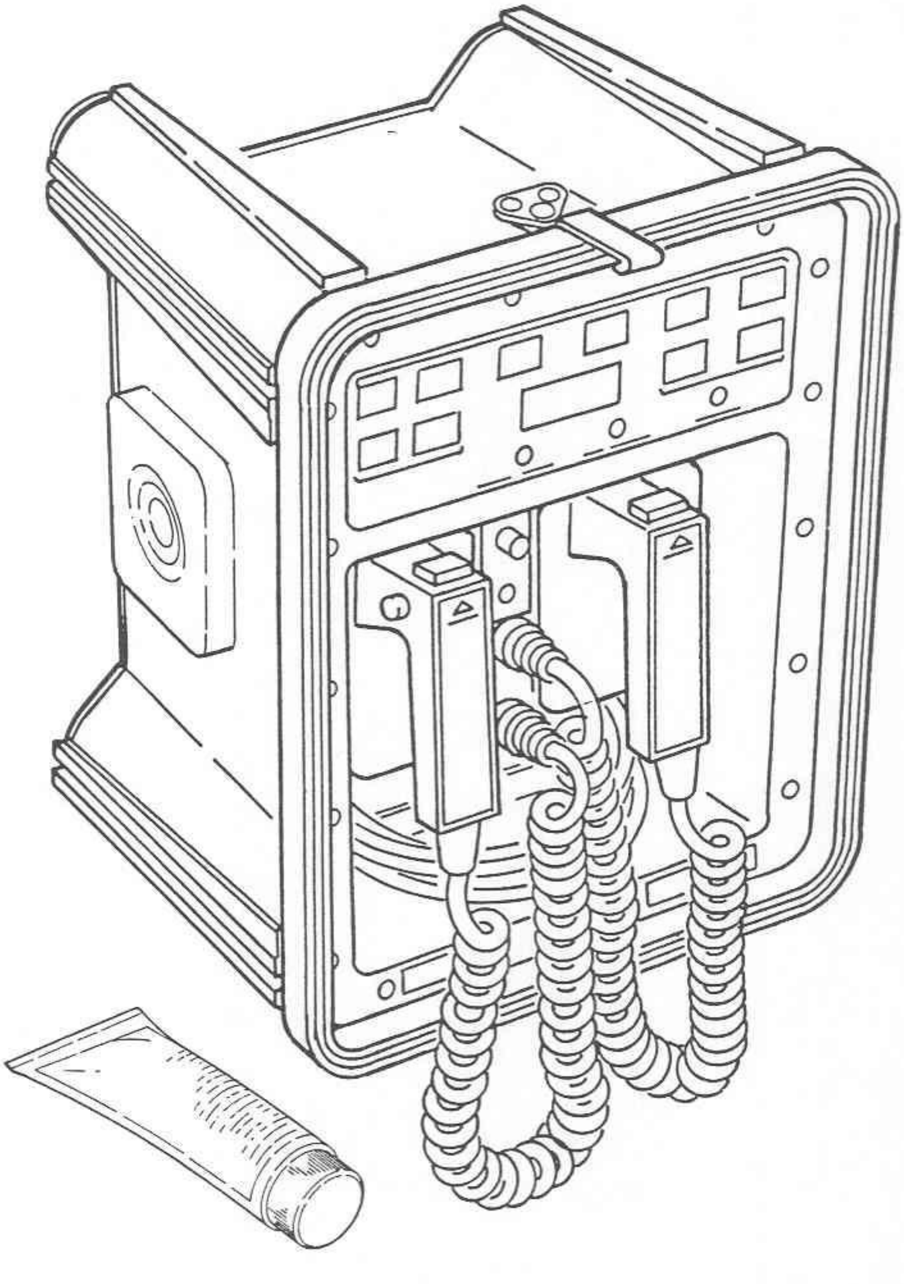


Figure 1-1. HP 43130M Accessories Supplied

1-1. INTRODUCTION

This Maintenance Service Manual provides the necessary maintenance instructions for the proper care and maintenance of the Hewlett-Packard model 43130M Defibrillator Module. Figure 1-1 shows an HP 43130M Defibrillator Module with all its externally supplied accessories.

The HP 43130M Defibrillator Service Manual has six sections:

- Section I, General Information.
- Section II, Theory.
- Section III, Checks and Adjustment.
- Section IV, Service.
- Section V, Troubleshooting.
- Section VI, Replaceable Parts.

The 43110MC Defibrillator/Monitor-Recorder module Operating Guide (shipped separate) has six sections.

- Section 1, General Information.
- Section 2, Operating Controls and Indicators.
- Section 3, Emergency Defibrillation Procedures.
- Section 4, ECG Monitoring.
- Section 5, Elective Cardioversion.
- Section 6, Checkout Procedure.
- Section 7, Operator Service.
- Section 8, Operational Checks.

Additional copies of the Operating Guide or the Service Manual can be ordered separately through your nearest Hewlett-Packard office.

1-2. SPECIFICATIONS

Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) Section 1 for a complete list of specifications.

1-3. SAFETY CONSIDERATIONS

The Defibrillator Module and all related documentation should be reviewed for familiarization with safety markings and instructions before operation. Refer to the Safety Considerations page found at the beginning of this manual for a summary of the safety information. Safety information for maintenance is found in appropriate places throughout this manual.

1-4. PUBLICATION CHANGE NOTICE

Publication change notices provide information necessary to update the manual. The notice is identified by the manual type and equipment model number.

1-5. DESCRIPTION

The HP 43130M Defibrillator module is a DC defibrillator featuring a Lown (damped sinusoidal) waveform, simple 1-2-3 operation, and AC or internal battery powered capability. It is designed to interconnect physically and functionally with the HP 43200M Monitor-Recorder module for the purpose of performing synchronized cardioversion and the ability to monitor the ECG using the paddle electrodes. Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) Section 1 for more information.

1-6. ACCESSORIES SUPPLIED

The accessories supplied with the Defibrillator module are shown in Figure 1-1.

1-7. EQUIPMENT REQUIRED BUT NOT SUPPLIED

A Monitor/Recorder module is required for the purpose of performing synchronized cardioversion and the ability to monitor the ECG.

The 43130M Defibrillator Module is designed to be used in conjunction with the HP 43200MD Monitor-Recorder module, and when both are connected, they form the HP 43110MC Defibrillator/Monitor-Recorder system. Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) for more information.

1-8. RECOMMENDED TEST EQUIPMENT

Table 1-1 lists the test equipment recommended for testing, adjusting and servicing the Defibrillator module. Essential requirements for each piece of test equipment are described in the Critical Specifications column. Other equipment can be substituted if it meets or exceeds the critical specifications.

1-9. INITIAL INSPECTION

Carefully inspect each shipping container for damage. If the shipping container or cushion material is damaged, it should be kept until the contents have been checked for completeness and the instrument has been checked for mechanical and electrical integrity.

1-10. STORAGE AND SHIPMENT

1-11. Environment

Defibrillator module should be stored in a clean, dry environment. The environmental limitations for both storage and shipment are as follows:

Temperature	−30 to +65°C
Altitude	0 to 50,000 feet
Humidity	< 95% RH 40°C

1-12. Preparation for Storage

The Defibrillator module can be stored for long periods of time provided proper precautions are taken prior to and during storage. Procedures are provided below for both short term and long term storage.

- SHORT TERM STORAGE (less than 6 months):

  1. Perform Operational Checks to verify unit is functioning. Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) Section 8 for information.
  2. Connect unit to AC power for a minimum of 24 hours with POWER key set to OFF/RECHARGE to fully charge battery.
  3. Disconnect unit from AC power for a minimum of 24 hours. With AC power cord unplugged, verify battery voltage is >12.5V Refer to Perform Battery Voltage Check (Section III, paragraph A) for procedure. If battery voltage is incorrect, troubleshoot using Section V.
  4. Remove Redux® gel, paste, etc.
  5. Thoroughly clean unit and accessories.

Table 1-1. Recommended Test Equipment

Instrument Name	Critical Specifications	Recommended Model	Use*
DIGITAL MULTIMETER	5 to 15 Vdc ±1% measurements 0.1 to 10Ω ±2% measurements	HP 3468A	C/A/T
ENERGY METER	5 to 400 Joule, critically damped sinusoidal waveform measurements with ±2% of full scale accuracy. Load resistance 50Ω ±0.5%.	Dempsey Model 429	C/A
LOGIC PROBE	TTL/CMOS	HP 545A	T
MONITOR-RECORDER MODULE	No substitute.	HP 43200MD	C/A/T
OSCILLOSCOPE WITH PROBES	25MHz bandwidth, dual trace	HP 1740A	T
PATIENT ECG SIMULATOR	Output Level: 1 mV normal sinus rhythm.	Dynatech Nevada ECG100	C
SAFETY ANALYZER	No substitute.	Dynatech Nevada 431F	C
SIGNAL GENERATOR	Sinewave, 3Vp-p at 5Hz	HP 8111A	A
STOPWATCH OR TIMER	Capable of measuring 2 to 12 second events with hand start/stop actuation to 1/4 sec. accuracy.		C

* C= Checks, A=Adjustment, T=Troubleshooting

- LONG TERM STORAGE (more than 6 months):
  1. Perform Short Term storage procedure listed above.
  2. Remove the Battery Assembly BT1 (Section IV, paragraph 4-3).
  3. Store Equipment and BT1 Battery Assembly separate as follows:

     Equipment can be stored (without battery) in the environmental limits as listed above indefinitely. Mark package with storage date.

     Battery should be stored at an optimum temperature of +5°C. Maintenance may have to be performed, depending on the length of time the BT1 Battery Assembly is in storage (see below). Mark package with storage date.

1-13. In Storage Maintenance

Battery Maintenance must be performed every five years (if stored at +5°C) as follows:

NOTE

If battery is stored in temperatures greater or less than +5°C, battery maintenance must be performed more often than every five years.

1. Charge battery (~14.3 Vdc float voltage) for a minimum of 24 hours.
2. Disconnect battery from charger for a minimum of 24 hours.
3. Measure battery voltage and verify reading is >12.5 Vdc.
4. Mark package with charge date and measured voltage.

1-14. Retrieval from Storage

Procedures are provided below for placing the Defibrillator Module in service after both short term and long term storage.

- SHORT TERM STORAGE RETRIEVAL (stored for less than 6 months):
  1. Connect unit to AC power for a minimum of 24 hours with POWER key set to OFF/RECHARGE to fully charge battery.
  2. Disconnect unit from AC power for a minimum of 24 hours.
  3. Perform Battery Voltage Check (Section III, paragraph A), Level II Performance Checks (Section III, paragraph B), and Safety and Maintenance Checks (Section III, paragraph C). If incorrect, adjust using Section III, and/or troubleshoot using Section V.
  4. Thoroughly clean unit.
  5. Restock accessories.
- LONG TERM STORAGE RETRIEVAL (stored for more than 6 months):
  1. Install BT1 Battery Assembly (Section IV, paragraph 4-3).
  2. Perform Short Term storage retrieval procedure listed above.

NOTE

Batteries which are being retrieved from storage may required several recharge/discharge cycles before maximum capacity is restored.

1-15. PACKAGING

Containers and materials used for original shipment of your HP 43130M are specifically designed for the instrument and are not readily available through Hewlett-Packard sales offices; it is recommended that you keep the packing materials for future use. If the instrument is returned to Hewlett-Packard for servicing, attach a tag indicating the product model number, serial number, return address, and a description of the problems encountered and service required. Mark the container FRAGILE to ensure careful handling. In every correspondence, refer to the instrument by product number and full serial number (e.g. HP 43130M, serial number 2400A00000).

Follow these general instructions when re-packaging with commercially available materials:

- Wrap the instrument in heavy cushioning material.
- Use a strong shipping container. A double-wall carton made of 160 kilogram test material is adequate.
- Use enough shock absorbing material (3 or 4 inch layer) around all sides of the instrument to provide firm cushioning and to prevent movement inside container. Protect the control panel with cardboard.
- Seal the shipping container securely.

2-1. INTRODUCTION

This section describes the theory of operation for the 43130M Defibrillator module. Information is presented, starting with a brief description of the major assemblies, and progressing into greater detail, down to the circuit level. Schematic and functional block diagrams located in Section 6 are referenced when necessary.

Theory of operation is not intended as a direct troubleshooting tool; however, the level of information presented will often help the technician when troubleshooting a malfunction in the Defibrillator module.

2-2. MODULE OVERVIEW (figure 2-1)

The primary function of the Defibrillator module is to provide a selected amount of energy to the defibrillator paddles as controlled by the operator. This process requires the interaction of many different circuits, and is briefly discussed below.

The Control CCA reads the energy select switches from the Front Panel Membrane Switch Assembly. If determined to be a valid charge request, the Control CCA displays the High Voltage Capacitors energy on the three digit Front Panel DISPLAY CCA.

NOTE

The number displayed is equal to the amount of energy that would be delivered to 50Ω.

The Control CCA then instructs the High Voltage Capacitor Charger CCA to start charging the High Voltage Capacitor.

The charging is completed when the energy on the High Voltage Capacitor reaches the selected energy setting. The Control CCA instructs the High Voltage Capacitor Charger CCA to stop charging, the charge done tone is output to the Speaker, the paddles charge done LED is turned on, and the energy is displayed on the front panel.

NOTES

Periodically the High Voltage Capacitor Charger CCA may be activated to maintain the energy on the HV capacitor.

The HV capacitor will remain charged for 60 seconds after the charge is completed. After 60 seconds, the Control CCA will discharge the HV capacitor using the Internal load. During the last 10 seconds, the charge done tone beeps.

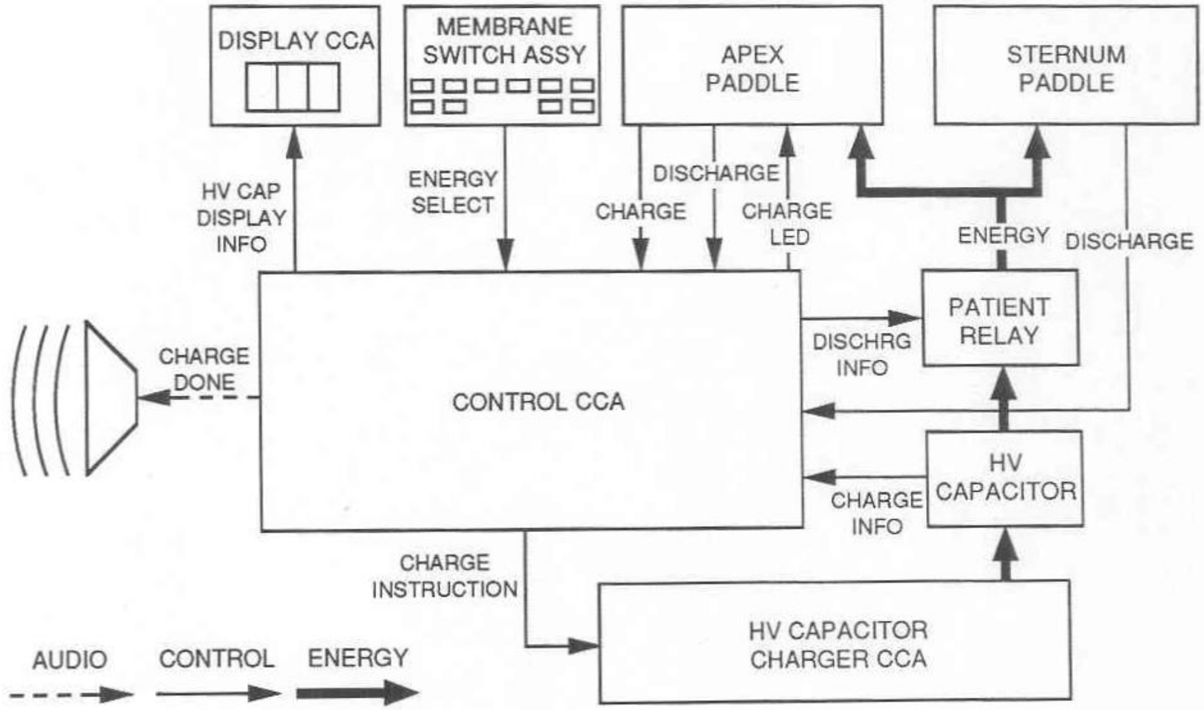

DISPLAY CCA
MEMBRANE SWITCH ASSY
APEX PADDLE
STERNUM PADDLE
HV CAP DISPLAY INFO
ENERGY SELECT
DISCHARGE
CHARGE
CHARGE LED
ENERGY
DISCHARGE
PATIENT RELAY
DISCHRG INFO
CHARGE DONE
CONTROL CCA
HV CAPACITOR
CHARGE INFO
CHARGE INSTRUCTION
HV CAPACITOR CHARGER CCA
AUDIO
CONTROL
ENERGY

Figure 2-1. 43130M Defibrillator Module Signal Flow Functional Block Diagram.

125 ms after the charge done tone comes on, the Control CCA begins checking to see if both paddles discharge switches have been pressed at the same time. When detected, the Control CCA activates the Patient Relay and the energy is discharged through the paddles.

After a discharge, the Control CCA continues to display the High Voltage Capacitor energy for 10 seconds, or until the energy decreases to less than 1 Joule.

For synchronized cardioversion, the charge and discharge sequence is the same except that the Control CCA does not activate the Patient Relay until an R-wave is detected using an external Monitor-Recorder module.

The Defibrillator module consists of three major assemblies. Each of these major assemblies is comprised of Circuit Card Assemblies (CCA) and major circuits composed of individual parts. The three major assemblies are:

- A1 Enclosure Assembly.
- A2 Chassis Assembly.
- A3 Front Panel Assembly.

2-3. A1 ENCLOSURE ASSEMBLY

The Enclosure Assembly, consists primarily of the physical outer case and related mechanical components. Electrically it can be broken down into one assembly:

- A1A1 Infrared Link CCA.

2-4. A1A1 Infrared Link CCA (figure 6-3)

The A1A1 Infrared Link CCA provides the means of communication between the Defibrillator module and the Monitor-Recorder module. Information is exchanged between the two modules using infrared optical signals. This assembly consists of transmitter and receiver circuits that interface with the A2A2 Control CCA, over ribbon cable A1A1P36.

Transmitter Circuit

The transmitter circuit converts serial data from the microcontroller (A2A2U101) into digital infrared energy (a logic low input causes infrared energy to be transmitted). R14 protects the comparator (U2A) input from potential ESD noise pulses. U2A inverts the signal and provides an open-collector drive to Q1. Q1 is a N-channel enhancement mode MOSFET providing the on/off gating of the current thru the emitter diode (DS3). R16, R17, and R18 provide current limiting of DS3, which sets the infrared output power of the transmitter circuit.

Receiver Circuit

The infrared receiver detects and converts infrared energy to logic level serial data, for input to the microcontroller. Infrared energy is detected by the PIN photodiodes (DS1 and DS2), which generate a small current. This current signal is amplified and converted to a voltage signal by the two-stage amplifier constructed from transistor array (U1).

The first stage of the amplifier consists of an emitter follower (U1A), an inverting amplifier (U1B), and another emitter follower (U1C). U1A amplifies and converts the photocurrent to a voltage. U1B provides inverting voltage gain. U1C provides buffering and a low impedance output to the next stage. R1 provides negative feedback to stabilize the trans-impedance of the stage. The first stage is coupled to the second stage using R5, which converts the output voltage of the first stage to a current.

The second stage consists of emitter follower (U1D), and inverting amplifier (U1E). U1D provides current gain and converts the current from the first stage to a voltage. U1E provides inversion and voltage gain.

R9 and C6 in the emitter of U1E are important for setting the dynamic range of the amplifier. They degenerate the DC gain, while preserving AC gain. This helps U1E recover quickly from saturation. R9 stabilizes the DC operating point, which allows the detection threshold to be closer to the saturation point. C2 and C5 provide compensation and increase the phase margin for stability.

Comparator (U2B) and associated resistors and capacitors are used to convert the amplifier output to a logic level signal before sending to the microcontroller. R13 provides protection from ESD noise pulses.

2-5. A2 CHASSIS ASSEMBLY

The Chassis Assembly consists of the sheet metal chassis and the components that mount on it. Electrically it can be broken down into five major assemblies/circuits:

- A2A2 Control CCA.
- A2A3 High Voltage Capacitor Charger CCA.
- Patient Circuit (A2C1, K1, L1).
- A2A1 Power Supply CCA.
- BT1 Battery Assembly.

2-6. A2A2 Control CCA (figure 6-5).

The A2A2 Control CCA controls virtually all of the functions of the Defibrillator module. The Control CCA is broken into four major circuits, and a separate schematic diagram sheet is provided for each individual circuit.

- Controller circuits (figure 6-5 sheet 2).
- Front panel control circuits (figure 6-5 sheet 3).
- Paddles ECG circuits (figure 6-5 sheet 4).
- DC-DC circuits (figure 6-5 sheet 5).

2-7. Controller Circuits (figure 6-5)

Controller circuits are provided on sheet 2 of 5 of the A2A2 Control CCA schematic. All components located on sheet two of the schematic diagram have a 1xx reference designator number. The Controller circuits provide overall control of Defibrillator module internal operations. The controller circuits consist of:

- 8051 microcontroller (U101).
- A/D converter (U102).
- CMOS digital gate array (U103).

Microcontroller (U101)

The 8051 microcontroller is the heart of the controller circuits. System control is accomplished either directly from the microcontroller's own I/O ports; or indirectly through the control gate array's (U103) I/O lines.

The microcontroller's firmware is executed once every 4.167 ms on a cyclic basis. The 4.167 ms software cycle is generated by a timer internal to U101. Software functions include servicing the A/D converter (U102); updating the display; reading the front panel and paddle keys; HV Capacitor (A2C1) charge and discharge control; controlling the two way infrared optical link; and system diagnostics.

Port 0 (P0.) of U101 is used as an address and data bus to allow communications with U102 and U103.

Port 1 (P1.) of U101 is used to monitor the user keys, control the front panel display, enable HV capacitor charging, and control the paddle charge done LED.

P1.0 and P1.1. When the Apex paddle charge switch is closed, PAD CHG SW (J7-5) is connected to PAD DISCHG SW (internal to the paddle), and the signal is pulled to +5V through R103. When the paddles charge switch is open, PAD CHG SW is at ground. This signal is input to inverter (U105A) and the output of the inverter drives port bit P1.0. A low level at P1.0 indicates the charge switch is pressed. R101, R102, and CR101 provide overvoltage protection for U105A in the event that both the charge and discharge switches are closed.

The signal PAD DSCHG SW, (J7-1) indicates when the discharge switches are both pressed. When the switches are open, the signal is pulled to +5V through R103,; and when closed, the signal is pulled to +12V (SWBATT). CR102, CR103, R104, and R105 provide logic level translation before the signal is input to CMOS inverter (U105B). The output of U105B is input to U101 P1.1. A low level at P1.1 indicates the discharge switches are closed.

P1.2, P1.3, P1.4, and P1.5. Used to read and control the front panel circuits (described later).

P1.6. ~CHG ENABLE is used to enable/disable the HV Capacitor charging circuits. A logic low will enable HV charging. R109, CR106, and CR107 are used to protect U101.

P1.7. Turns on or off the Apex paddle charge done LED. When P1.7 is a logic high, Q101 is on, Q102 is on, and the LED is on. When P1.7 is low, the LED is off. CR108 and CR109 protect the circuit from electrostatic discharges directly to the LED.

Port 2 of U101 is not used.

Port 3 of U101 is used for communication with the A1 Enclosure Assembly A1A1 IR Link CCA.

P3.0. Serial receive port that receives signals optically from the A1A1 IR Link CCA to U101 The signal from A1A1 is clamped by R106, R107, CR104, and CR105. This protects the inverting buffer (U105D). U105D is used to protect U101.

P3.1. Serial transmit port sends signals from U101 to A1A1 IR Link CCA. Buffer (U105F) provides additional drive capability and protection for U101. The primary function of R112, R113, CR110, and CR111 is to protect U105F.

U101 also performs diagnostic checks of the module every 4.167 ms. These checks are to verify that the unit is operational and can be safely charged and discharged. If an unsafe condition is detected, U101 will disable the charge and discharge sequences, and display error messages on the front panel. Error conditions that are checked include:

- A/D converter (U102) multifunctioning.
- Supply voltages out of specification.
- Safety relay circuitry stuck, open, or closed.
- HV capacitor overcharged, leaking, or arcing.

A/D Converter (U102)

The A/D converter is an 8-bit successive approximation type with an internal 4 channel analog multiplexer, and internal clock to generates its own timing. Typical conversion time is 40 microseconds. A +5 volt reference is used as the reference input.

Conversion is initiated when U101 executes an external data memory write instruction to the address that U102 occupies in the memory map. When this occurs, the gate array selects U102. The data written to U102 is the multiplexer channel address of the signal intended for conversion. The actual conversion begins when the write signal returns high at the end of the external data memory write instruction.

After the conversion is completed, U102 generates an interrupt to U101, which reads the conversion result with an external data memory read instruction, and then may start another conversion. If U102 does not respond to requests by U101 to perform a conversion, error message "E7" will flash.

Four conversions are performed each 4.167 ms software cycle. Conversions are done on the:

- Patient ECG signal (ECG).
- HV Capacitor voltage (VCAP).
- Battery voltage (SWBATT).
- Supply voltages (VSPLY).

CH1. Measures the ECG signal from the paddles. The input, PADDLES ECG (from sheet 4 of 5), is the amplified and filtered ECG signal which has already been processed by the ECG circuits. Before received by U102, the signal is processed by operational amplifier (U104A) and associated components. This circuit performs three functions, it level shifts the bipolar ECG signal to 2.5 volts to center it in U102's range; it performs a third order low pass function to remove any high frequency noise; and it provides a low impedance drive to U102.

CH2. Monitors the voltage on the High Voltage Capacitor (A2C1). R119 is used to calibrate the delivered energy from the defibrillator, primarily due to variations of A2C1 from its nominal 54 µF value. R121 and C103 provide additional noise immunity for the VCAP signal.

CH3. Monitors the internal power supplies. R116, R117, and R118 sum the three supplies such that the nominal signal at channel three is 2.67 volts. If the signal exceeds 3.3 volts or falls under 2.1 volts, U101 will flash the error message "E6".

CH4. Monitors the battery voltage, SWBATT. R114, R115, and C102 divide the battery voltage to within U102's range and provide noise immunity. When U101 detects the battery voltage below 11.8 volts, it turns on the front panel low battery LED.

CR112 through CR119 are schottky diodes used to protect U102.

Gate Array (U103)

The control gate array is a collection of several smaller digital circuits. It generates many of the system timing signals, and provides I/O expansion for U101. The major functional areas of the gate array are:

- Clock oscillator.
- System timing chain.
- Memory map control logic.
- Control registers.
- Tickle/reset circuit.
- Charge rate control.

Clock Oscillator. Uses external crystal Y101 and associated components to generate a 12 MHz clock signal. The clock is used by both U103 (XTALIN) and U101 (OSCOUT).

System Timing Chain. Divider network internal to U103 which uses the 12 MHz clock as an input, and generates additional timing signals. The upper portion of this divider chain is a free running ripple counter which cannot be reset by U101.

The output of one stage of this divider is available as the output signals ECGCLK and ~ECGCLK. These are complementary 31,250 Hz square waves used as clocks by the ECG circuits.

The output of another stage is used to generate the signal CHGTONE, a 1,953 Hz square wave used to drive the audible tone. External to U103, this tone is divided by two (U107A) to generate 976 Hz. This frequency better couples the speaker energy into the storage pocket, resulting in a louder tone. Q105 provides the current gain necessary to drive the 8Ω speaker. C112 AC couples the drive signal to Q105 to prevent the transistor from being left in an on state.

The lower portion of the divider chain can be controlled by U101. It is used to generate the tickle/reset signal, part of the hardware watchdog circuit.

Memory Map Control Logic. Internal to U103, consisting of an address latch and combinational logic to decode the address. The memory mapped devices are accessed by memory read/write instructions from U101. P0 on U101 is used as the external address/data bus.

Control Registers. Three control registers internal to U103 that are configured as external memory locations to U101. The registers expand the I/O capability of U101, and are referred to as ports 4, 5, and 6. Each register is updated once every 4.167 ms software cycle. The registers are used for internal control of U103, and also as direct outputs to other parts of the system.

Output signal PATRLY is controlled by one of the bits in port 4, and is a logic level output that commands one of the darlington drivers in U106. U106 is capable of sinking the approximately 1 A of current needed to actuate the Patient Relay (A2K1). When PATRLY is a logic high, A2K1 is activated, connecting the High Voltage Capacitor's stored energy to the paddles.

Output signal SFTYRLY is also controlled by one of the bits in port 4, and also controls one of the darlington drivers in U106 providing increased current sink capability. When SFTYRLY is a logic high, the safety relay (A2A3K1) is activated (opened), disconnecting the shunt resistance which is across the High Voltage Capacitor and allowing the capacitor to be charged. SFTYRLY is also used to prevent low battery shutdown during charging.

Output signals GAIN2, GAIN1, and GAIN0 are controlled by bits in port 5, and are used to control the gain of the paddles ECG amplifier (sheet 4 of 5).

Tickle / Reset Circuit. The tickle/reset circuit provides a means of software recovery for U101. The circuit is basically a ripple counter that is driven by the system timing chain. If allowed to run freely the counter will generate a signal that is 6.4 ms high and 6.4 ms low. The output of this counter is U103 pin 65 (CONRST). CONRST is connected to the power-up reset circuit.

The power up reset circuit consists of R130-R134, C110, C111, Q103, Q104, and U105C. The output of this circuit is connected to the RST (reset) pin of U101.

When power to the module is first turned on, there is no charge on C110 and this forces U101 into reset (input signal RST is a logic high). After C110 charges, the RST pin will go low and U101 will begin to execute its ROM based program. After Q103 turns off, U103 signal CONRST has control over the reset pin of U101. Thus U101 can be reset by either U103 or the power-up circuit.

Under normal operation, U101 "tickles" or resets the tickle/reset ripple counter once each 4.167 ms software cycle. This prevents CONRST from ever going high and resetting U101. However, if U101 operation is upset and fails to "tickle", then CONRST will reset U101 within 4.864 ms. When reset, the software will start over from program address location 00 and "tickle" rapidly for 25 ms before resuming normal operation. "Tickling" is accomplished by writing to one of U103 control registers. The tickle signal from U103 is output as a test signal on pin 2.

Charge Rate Control. U103 also exercises charge rate control of the A2A3 High Voltage Capacitor Charger CCA using the CHGRATE signal. CHGRATE is a 15.625 kHz square wave with variable duty cycle. The duty cycle is selected by U101 using the Control Registers. The high period of the 15.625 kHz signal can be selected to be between 28.5 to 35.5 µsec.

Power Up Detect. Pin 3 of U103 is monitored by U101 to determine if the instrument's power has just been turned on. C107 is connected to pin 3 and charged through an internal pull-up transistor. U101 checks the logic level of pin 3 (which effectively is the charge on C107) to determine if the unit has recently been turned on.

2-8. Front Panel Control Circuits (figure 6-5)

Front Panel Control circuits are provided on sheet 3 of 5 of the A2A2 Control CCA schematic. All components located on sheet three of the schematic diagram have a 2xx reference designator number. The Front Panel Control circuits interface the 10 user actuated front panel switches to the Controller circuits, and directly control the Front Panel LED's. Neither the switches or the LED's are physically part of the A2A2 Control CCA, however, they are directly connected using cable assemblies.

The Front Panel Control circuits consist of three digital shift registers (U201, U203, and U205), two transistor arrays (U202, and U204), and additional discrete components.

Each of the 10 front panel membrane switches is configured so that the individual switch signal line is shorted to SW COM (switch common) when the switch is depressed. On the A2A2 Control CCA, SW COM is connected to DGND. Therefore pressing a switch effectively connects the individual signal line shown on connector J2 to ground.

The Front Panel Control circuits perform the following functions:

- ON/OFF Operation.
- Detecting Switch Presses.
- Controlling Front Panel LED's.

ON/OFF Operation

The Defibrillator is turned on by pressing the front panel "ON" switch. This connects one side of R203 to ground and pulls down signal ON/OFF using CR203. Pulling ON/OFF to near ground will turn the defibrillator on. As the instrument turns on, +5V supply begins to operate and makes Q201 conduct. This holds ON/OFF near ground and keeps the instrument on even when the front panel ON key is released.

Pressing the front panel OFF/RECHARGE switch pulls down on the gate of Q201, stopping it from conducting, and allowing ON/OFF to float high. This turns the defibrillator OFF. The additional discrete components near Q201 are used to protect the MOSFET and to prevent transient noise from triggering the instrument ON or OFF. CR203 and CR204 allow presses of the ON switch to be detected by U101 after the defibrillator has already been turned on. When power is already on, presses of the ON key are interpreted as a DISARM request.

Detecting Switch Presses

There are 10 front panel switches located on the A3A4 Membrane Switch Assembly. Pressing any switch (except OFF/RECHARGE) can be sensed by U101. Once each 4.167 ms software cycle, U101 reads the state of the switches. A switch press is only considered valid, and acted upon, if it is detected for eight consecutive software cycles.

Switches are read in the following manner.

> Under software control, FP STROBE signal is switched high. This latches the stage of switches into the parallel to serial shift register (U205). Subsequent toggles of signal FP SER CLK output U205 data serially onto signal FP SER FROM SWS. The data is read by U101 via FP SER FROM SWS signal.

Controlling Front Panel LED's

The Front Panel Control circuits also directly control which of the front panel A3A3 Display CCA LED's and seven segment display digits are on or off. This is accomplished by the two serial to parallel shift registers and the transistor arrays.

Data to control the LED's is sent serially by U101 to the shift registers (U201/U203). When signal FP STROBE is a logic low, subsequent toggling of the FP SER CLK will shift data on the signal FP SER TO LEDS into U201. U201 is chained to U203 so that sixteen bits of serial data output from U101 will fill U201 and U203.

Two transistor arrays (U202 and U204) are used to provide higher current drive capability to the LED's then would be possible using only the CMOS shift registers. U202 is an array of NPN transistors configured to source current from the +8.4V supply connected to pin 9. U204 is an array of NPN transistors configured to sink current to DGND. U202 and U204 are built so that a logic high from the U201 and U203 will enable sourcing/sinking current and a logic low will disable current.

NOTE

The physical representation of the pins on the schematic is logical so that input pin 1 of U202 controls output pin 18, pin 2 control pin 17, etc.

The three 7 segment displays on A3A3 Display CCA are time multiplexed, so that only one digit is on at any one time. That is, only one of signals DIGIT 100, DIGIT 10, or DIGIT 1 will be sinking current during any one 4.167ms software cycle. The on/off cycle for any one digit is 33% on, 67% off.

2-9. Paddles ECG Circuits (figure 6-5)

Paddles ECG circuits are provided on sheet 4 of 5 of the A2A2 Control CCA schematic. All components located on sheet four of the schematic diagram have a 3xx reference designator number. The Paddles ECG circuit allows the monitoring of the patients ECG without connecting electrodes, using the Apex and Sternum Paddles.

ECG is a low level signal (typically 1 mV), that must be extracted from high level common mode noise signals (typically 10 V) generated by capacitive coupling of the patient to surrounding AC sources. The ECG circuit has isolated and grounded sections to protect the patient from possible hazards associated with electrical connections to the body. The isolated section circuits are electrically isolated from instrument ground. Since the patient is directly connected only to the isolated section, the patient is electrically isolated from instrument (and earth) ground.

Operation of the Paddles ECG circuit is explained by sequentially discussing the path of the ECG signal beginning at the patient and continuing until it is converted into a digital format for further processing by the Controller circuits. The Paddles ECG circuit consists of:

- Protection Circuits.
- First Gain Stage.
- Chopper Modulator.
- Isolated Power Supply.
- Bandwidth Filter.
- Second Gain Stage.
- Variable Gain Stage.

Protection Circuits

The protection circuitry is the first that a signal from the patient encounters. The purpose of these circuits is to prevent damage to the amplifier electronics. Since the ECG amplifier is electrically connected to the paddles at all times, the circuit must be capable of surviving a defibrillator discharge. A network of current limiting resistors (R301 thru R310), and clamp diodes (CR301 thru CR312), is connected to perform the protection function.

First Gain Stage

After the protection circuitry is the first gain stage, a differential amplifier with a gain of about 10. The differential amplifier consists of U301A, U301B, and R311 - R313. The output of the differential amplifier is input to the Chopper Modulator circuit.

R314, R315, and C302 form a low pass filter that decouples the differential amplifier from the switching transients associated with analog multiplexer (U302). C302 serves as a low impedance source to rapidly charge or discharge the transients inherent in switching U302.

Chopper Modulator

The Chopper Modulator circuit is a standard technique used to allow passage of the nominally low frequency ECG information across an isolation transformer. Analog multiplexer (U302) is switched at 31,250 Hz to repetitively reverse the connection between the First Gain Stage output and the isolation signal transformer

(T301). This modulates the low frequency ECG signal on a 31,250 Hz carrier. The chopping technique is inversely performed on T301 output to reconstruct the low frequency ECG information in the grounded section.

The square wave signal available at the output of T302 provides the synchronous clocks required for this chopping/de-chopping process.

Isolated Power Supply

The power to operate the isolated circuits is generated by push pull converter (T302 and associated components). The center tapped primary is alternately driven from the +5V supply by Q301 and Q302 at 31,250 Hz. CR321 and CR322 protect Q301 and Q302 from transients associated with switching the inductive load. In the isolated section, the secondary windings output is full wave rectified to generate bipolar supplies of about ± 6 V.

After analog multiplexer (U303) reconstructs the chopped waveform, the signal is low pass filtered by R324 and C305 to remove switching transients introduced by the chopping process.

Bandwidth Filter

The signal is then passed through a high pass filter formed by C306, R325, and R326. This AC coupling is required to remove DC offsets, often present due to the patient electrodes and conductive pastes. The cutoff is set to allow 0.5 Hz frequency response of the ECG amplifier.

Second Gain Stage

After low frequency filtering, the signal is routed to the second gain stage. This is a standard noninverting amplifier configuration, using operational amplifier (U304) with a gain of about 60. The gain is adjustable using R331. This accuracy adjustment is used to null out gain errors anywhere in the overall signal path. The offset of this stage is also adjustable using R328 and used to accurately center the ECG waveform on the output displays.

Variable Gain Stage

The output of the second stage is routed to the variable (third) gain stage. This gain stage combines an operational amplifier (U306) with a one-of-eight analog multiplexer (U305), and discrete resistors. It allows the choice of eight gain settings. When combined with the previous two gain stages, this provides overall ECG amplifier gain selectable at 250, 400, 650, 1000, 1300, 2000, 3000, or 4000. Logic lows at all three control inputs of U305 will select a gain of 250, all highs select a gain of 4000, etc.

The output of the variable gain stage is labelled PADDLES ECG. This signal is input to a final buffer stage before conversion to a digital format (discussed later).

2-10. DC-DC Circuits (figure 6-5)

DC-DC circuits are provided on sheet 5 of 5 of the A2A2 Control CCA schematic. All components located on sheet five of the schematic diagram have a 4xx reference designator number. The DC-DC circuits control the distribution of power to the Battery Assembly (BT1) and instrument circuits, from either BT1 or the AC line connected A2A1 Power Supply CCA. The DC-DC circuits also generate the various internal voltage supplies used within the instrument.

Normal Operation

DC-DC circuits can easily be understood by first examining the normal operating mode. Some general statements can be made which highlight the circuits operation before detailing how specific circuits operate.

With a properly working instrument and a good battery, if K402 is closed, the instrument is on. Closing K402 provides SWBATT signal, and the +8.4, +8, +5, +5.0V REF, and –5 volt supplies all start up, and the instrument turns on. Relay K402 can often be heard as an audible click when the instrument is turned on or off.

Secondly, if this properly working instrument is connected to an AC source, K401 will close. When not connected to the AC line, K401 will be open. K401 can often be heard as an audible click when the AC line is connected or disconnected.

Many of the DC-DC circuits are directly associated with controlling if K401 and K402 are opened or closed.

Controlling Relay K401

DC-DC circuits are connected to the A2A1 Power Supply CCA by three pin connector P13. When the instrument is properly connected to the AC line, the Power Supply CCA provides +14.3 volts at about

8 A. The third connection, POWERFAIL, is a high impedance signal during normal operating conditions.

The +14.3 V (VSUPPLY) biases on CR401 to about 5.11 volts. R405 and R406 divide the VSUPPLY to about 4.84 volts so that comparator (U401A) will be in its output high state. The output of U401A being high causes Q401 to turn on, and energizes the coil of K401, closing the relay.

When the A2A1 Power Supply CCA is not providing VSUPPLY, K401 cannot be energized. This is because VSUPPLY provides the voltage to hold the K401 closed. Keeping K401 open prevents A2A1 and other components from draining the battery.

Over Voltage Protect

If for some reason the A2A1 Power Supply CCA is putting out a voltage greater then the expected +14.3 V (VSUPPLY), then the Over Voltage Protect circuit is triggered. If VSUPPLY is greater than about +15.1 V, the divided down signal generated by R405 and R406 will exceed 5.11 volts. This will force the output of U401A low, turning off Q401, and opening K401. This prevents overcharging of the battery and protects the circuits after K401.

Powerfail Mode

If the AC line voltage is too low to allow the A2A1 Power Supply CCA to provide the expected +14.3V, A2A1 will activate POWERFAIL signal. The POWERFAIL signal provides a low impedance path in parallel with CR401, shunting current away and preventing it from biasing up to the normal 5.11 V. The divided down signal generated by R405 and R406 will cause U401A to turn off Q401 and open K401.

Battery Charging LED

U401B is used to control the front panel A3A3 Display CCA Battery Charging LED. When the output of U401B is low, Q402 is on, and the LED is on. When the output of U401B is high, the LED is off.

When K401 is closed, VSUPPLY is connected to the Battery Assembly (BT1) via P12 and VBATsense is nearly equal to VSUPPLY. Since R414 and R415 divide VSUPPLY to a smaller signal than R412 and R413 divide VBATsense, the U401B output is low and the battery charging LED is on. Thus the LED is normally on when K401 is closed. An exception to this occurs if the thermal fuse in BT1 has opened. When the fuse is open VSUPPLY is greater than, not equal to VBATsense, and the battery charging LED will remain off even though the instrument is connected to the AC line and K401 is closed.

When the AC line is not connected, VSUPPLY is less than VBATsense, and the open collector output of U401B will not sink current without power applied to itself. The power to U401 is provided by VSUPPLY, which is unavailable. This causes the battery charging LED to be off when the AC line is not connected. R412 and R413 provide a small, but ever present drain on the battery.

Controlling Relay K402

The circuits that control K402 include Q403, programmable reference (U402), and associated components.

U402 works as follows. The signal between U402 pins 8 and 6 is the input. If the voltage at pin 8 exceeds the voltage at pin 6 by more than 2.5 volts, then the signal at pin 1 is a low impedance voltage source of 2.5 volts, capable of sinking current into pin 1. If the signal between pins 8 and 6 is less then 2.5 volts, then pin 1 is a high impedance.

The normal ON/OFF function of K402 occurs as follows. When the instrument has been off for a few seconds, C403 is charged to battery voltage thru R419. Pressing the front panel ON switch pulls signal ON/OFF (connected to U402 pin 6) near ground. The charge stored on C403 holds U402 pin 8 to more than 2.5 volts above pin 6 long enough for K402 to turn on and the instrument to power up. The instrument will stay on as long as the battery voltage is greater then about +11.2 volts. This threshold is set by R419, R420, and the hysteresis from R421. If the battery voltage drops below 11.2 volts, U402 pin 8 will not exceed pin 6 by 2.5 volts, and Q403 will turn off.

Disabling Low Battery Shutdown

When the instrument is operating with a low battery, and a HV Capacitor (A2C1) charge is requested, the high current demand may momentarily cause the battery voltage to drop below +11.2 volts. The SFTYRLY signal is used to prevent this low battery condition from turning off the instrument.

A logic high (+5 V) signal coupled through CR404 holds U402 pin 8 high enough to prevent a low battery shutdown whenever SFTYRLY is high. SFTYRLY is primarily intended to control the Safety Relay (A2A3K1). A2A3K1 is always actuated before beginning an A2C1 charge cycle. SFTYRLY remains high until A2C1 energy is discharged, preventing low battery shutdown during A2C1 charge cycles.

Internal Power Supplies.

When the instrument is on, K402 provides battery voltage (SWBAT) to the circuits used to generate the various internal power supply voltages.

Linear, three terminal, voltage regulator (U404), generates +8.4 volts to power the A3A3 Display CCA LED's. U404 has a TO220 package type and is mounted on a heat sink.

Linear, three terminal, voltage regulator (U405) generates +8 volts used primarily to power the analog circuitry in the instrument. U405 has a TO92 package type.

Linear, voltage reference (U403) is used to generate an accurate +5.0 volt source which drives the reference input for U102. U403 has an eight pin DIP package.

DC to DC converter control (U406) is used to generate +5 volts to power the digital circuits. U406 contains an internal reference, controllable oscillator and high current switch, and is combined with L401, C427, and CR407 to step down SWBATT signal. R426 and R427 feedback the actual +5V signal to close the loop around U406. CR411 serves to protect circuits in the event of an overvoltage failure.

The switching output from U406 is used to pump charge through C421 to C422, generating a negative voltage across C422. Negative linear, three terminal, voltage regulator (U407) then provides a stable –5 volt supply used primarily to power the analog circuitry in the instrument.

Multiple additional bypass capacitors are shown in the DC-DC circuits. Each is used to provide a local, low impedance source to a particular integrated circuit.

2-11. A2A3 HIGH VOLTAGE CAPACITOR CHARGER CCA (figure 6-6).

The A2A3 High Voltage Capacitor Charger CCA accepts and executes command signals from the A2A2 Control CCA to charge or disarm the A2C1 High Voltage Capacitor The A2A3 High Voltage Capacitor Charger CCA circuitry is broken into 12 major circuits.

- Power Conditioning circuit.
- Safety circuit.
- Pulse Width Modulator.
- Charge Disable circuit.
- Ramp Generator circuit.
- Charge Rate Threshold Generator circuit.
- Low Battery Sense circuit.
- High Current Switch Sense circuit.
- Primary Current Sense circuit.
- Transformer/Rectifier circuit.
- Capacitor Current Sense circuit.
- Capacitor Voltage Metering circuit.

Due to the numerous circuits present, a brief charger overview is presented before the individual circuits are discussed.

The A2A3 High Voltage Capacitor Charger CCA operates as a variable frequency flyback DC-DC high voltage switching power supply to charge the chassis mounted High Voltage Capacitor (A2C1). Charging begins after receiving the proper SAF RLY DRIVE, CHG ENBL, and CHG RATE CNTL signals from the A2A2 Control CCA. The Pulse-Width Modulator outputs a pulse, the duration of which is dependent upon the time required for the Charge Rate Ramp to reach the Charge Rate Threshold. During this time, the High Current Switch is turned on resulting in a current ramp in the transformer primary. At the end of the Pulse-Width Modulator output pulse duration, the High Current Switch stops conducting and the Transformer/Rectifier secondary conducts current into A2C1. The Capacitor Current Sense circuit then detects current which causes it to inhibit the restart of another Pulse-Width Modulator output. When A2C1 current reaches zero the entire cycle is repeated.

The capacitor voltage is scaled and buffered by the Capacitor Voltage Meter circuit for output to A2A2.

The Power Conditioning Circuit provides bypassing for the switched battery input (SW BAT), and also provides fusing and bypassing for the unswitched (V RAW) input.

The Safety Relay Drive input (SAF RLY DRIVE) to the Safety Circuit operates to disconnect a shunt resistor from the A2C1.

A number of signals and blocks serve as inputs to the Pulse Width Modulator and influence its output.

> The Charge Disable circuit uses SAF RLY DRIVE input as well as the Charge Enable (~CHG ENBL) input to enable charging as required.
>
> The Charge Rate Ramp Generator generates a voltage ramp which is slower when the battery voltage is lower to partially compensate for slower charging under low battery conditions. The charge rate is varied remotely by duty cycle modulation into the Charge Rate Control (CHG RATE CTRL) input which is received by the Charge Rate Threshold Generator circuit. This circuit also AC couples CHG RATE CTRL to protect against an erroneous stuck-high condition.
>
> The Low Battery Sense circuit disables defibrillator charging if the battery voltage (SW BAT) drops below 10 volts.
>
> The Primary Current Sense circuit monitors the Transformer/Rectifier primary current for a possible overcurrent condition, in which case the Pulse Width Modulator would terminate its output pulse.
>
> Finally, the Pulse Width Modulator circuit receives the output from the Capacitor Voltage Meter circuit to disable charging in the event of a runaway charge condition where A2C1 reaches an unacceptably high voltage level.

2-12. Power Conditioning Circuit

High and low current battery and ground lines (V GND/GND) enter the A2A3 HV Capacitor Charger CCA on separate lines. The ground lines are connected together on A2A2. The high current battery line (V RAW) is fused by F1 and is then filtered by C8. C8 is a low ESR capacitor used to supply the high current surges required in the charging circuitry. The low current battery line (SW BAT) is bypassed by C2 and C9 to the low current ground. GND is used as an analog ground reference for the Capacitor Voltage Metering circuit.

2-13. Safety Circuit

The Safety circuit is composed of K1, R1, CR1, C11, and R19. SAF RLY DRIVE is enabled (driven low) by A2A2. The normally closed, high voltage relay (K1) will then open, which disconnects R1 from the negative A2C1 terminal. When K1 is de-energized (closed), R1 will discharge A2C1. Disconnecting power to the unit also causes K1 to close, safely shunting A2C1. CR1 provides diode clamping of the relay coil's inductive spike when K1 becomes de-energized. CR1 also helps to protect the drive circuitry from voltage spikes which are capacitively coupled through K1 when the opening/closing relay contacts undergo rapid voltage swings. C11 and R19 are K1 contact snubber components that help to reduce the rate of voltage change across the contacts during contact opening or bounce.

2-14. Pulse Width Modulator

A block diagram level representation of this IC, along with a pin diagram is shown in figure 6-6.

The output stage is an emitter follower making the output voltage slightly less than the switched battery voltage (SW BAT) when the output transistor is turned on, and will be floating when the output transistor is off or disabled. Resistors R11 and R12 provide the only current sinking of the output. The pulse width modulator's internal 5 V reference voltage is bypassed by C1.

There are five conditions which can cause the output to turn off:

1. If current is sourced into pin 10.
2. If the voltage at pin 7 is greater than at pin 9.
3. If the voltage at pin 1 is greater than at pin 2.
4. If a voltage > 3 V is placed on pin 3.
5. If the voltage at pin 4 exceeds the voltage at pin 5 by ≥200 mV.

Any one of conditions 3 through 5 will also cause an internal Darlington transistor to pull the voltage at pin 7 down to about 0.8 volts. It should also be mentioned that pin 9 is the output of a transconductance operational amplifier in the Pulse Width Modulator, the inputs of which are pins 1 and 2. Pin 9 is a current source of about 100 μA at essentially any time that the voltage at pin 2 is higher than that at pin 1 (unless condition 5 is met).

2-15. Charge Disable Circuit

R2, CR2, and CR3 form the Charge Disable circuit. In order for the charger to operate, the CHG ENBL input must be brought low and the safety relay (K1) must be driven (SAF RLY DRIVE low). The diodes provide a wired OR function.

2-16. Ramp Generator Circuit

R3 and C3 form the Ramp Generator circuit. The exponential voltage rise is terminated after only a few volts excursion, when it reaches the voltage at U1 pin 9, or when any of the other conditions described in the Pulse Width Modulator section are met, so the ramp is approximately linear. When the battery voltage is lowest, the ramp is the slowest (in attaining a given value). This increases the T1 primary on-time in partial compensation for the decreased primary voltage.

2-17. Charge Rate Threshold Generator Circuit

C4, CR4, CR5, R4 - R6, C5, and U2C form the Charge Rate Threshold Generator. The Charge Rate Control signal (CHG RATE CTRL) from A2A2 is a 15.6 kHz variable duty cycle logic level square wave. A higher duty cycle yields a higher charge rate threshold, which will cause a faster A2C1 charging. C4 and CR4 AC couple and rectify CHG RATE CTRL so that if the incoming signal is erroneously stuck high the charge rate threshold will go low. R4, R5 and C5 filter the AC component, and U2C buffers that averaged value. CR5 assures that the output of U2B will only sink current from U1 pin 9.

2-18. Low Battery Sense Circuit

R7 and R8 divide the battery voltage (SW BATT) in half. C6 filters the divided voltage. If the resulting voltage drops below 5 volts, then the output of U2B will sink current and disable the output of U1.

2-19. High Current Switch Sense Circuit.

A high current output from U1 turns on the high current switch (power MOSFET Q1). Upon removal of the high current output from the U1, R11 and R12 will discharge the gate capacitance, turning Q1 off. If the drain voltage approaches an unsafe value for the device, CR6 will pull up the gate voltage so that Q1 will turn on and keep the drain voltage at a safe level. CR7 inhibits conduction of CR6 when Q1 is turned on. CR8 protects the device from spurious transients that could damage the gate-source junction. Q1 is mounted on a heatsink (heatsink is electrically at drain potential).

2-20. Primary Current Sense Circuit

R9, R10, and C7 form the Primary Current Sense circuit. The voltage across the current measuring resistor (low inductance resistor R10), is directly related to the primary current. R9 and C7 form a filter for the signal's high frequency components.

2-21. Transformer/Rectifier Circuit

The transformer/rectifier circuit consists of the primary winding, the secondary winding, the core and the high voltage rectifier of T1. The metering resistor is discussed in the Capacitor Voltage Metering circuit.

When Q1 turns on, approximately full battery voltage is applied across the primary winding of T1. The high voltage rectifier is reverse biased; the rectifier anode is at a negative voltage equal in magnitude to the primary winding voltage times the turns ratio (66). The constant voltage across the primary inductance causes a constant slope current ramp in the primary circuit. When Q1 turns off, the flux in the core of T1 causes current to flow in the secondary winding. The secondary voltage rises rapidly until the high voltage rectifier becomes forward biased. At that time, current is conducted into A2C1's positive terminal. The initial rectifier current is related to the ending primary current by the turns ratio; and because the secondary inductance is held at a nearly constant value (about the average voltage of A2C1), the current ramps down nearly linearly. When zero current is detected by the Capacitor Current Sense circuit, the charging cycle is repeated again. Note that when A2C1 is at a high voltage, the secondary conduction time is less than when it is at a low voltage; hence the variable frequency capacitor charging.

NOTE

A number of parasitic capacitances and stray or leakage inductances will have an effect on the voltage and current waveform.

2-22. Capacitor Current Sense Circuit

Current from A2C1's negative terminal, which flows during the time the rectifier in T1 is forward biased, flows to the secondary through CR10. At that time, U1 pins 11 and 14 are low so that R13 is essentially in parallel with R15. This reduces the divided voltage that would be produced by R14 and R15 alone. CR10 voltage is then greater than the resulting voltage on U2A pin 3, so the output of U2A is open circuited. R16 and Q2 then drive U1 pin 3 high, preventing U1 output from going high. When current in the capacitor ceases, the voltage across CR10 becomes less than at U2A pin 3 and the cycle holdoff signal at U1 pin 3 goes low. At that time U1 pins 11 and 14 will go high, which raises the voltage on U2A pin 3 via R13. During this time, some current will flow alternately in CR9 and CR10 due to the high voltage rectifier's capacitive coupling of transformer secondary ringing. The output of U2A will not toggle because of the increased threshold on pin 3 during primary conduction.

2-23. Capacitor Voltage Metering Circuit

Transformer T1 contains a HV resistor connected on one side of the high voltage rectifier cathode, which is at the high voltage capacitor voltage. The other side comes out of T1 on pin 5 and connects to R17. This divides the high voltage to a level below about 5 volts. C10 filters any noise and U2D buffers the voltage. CR11 protects U2D from any positive or negative spikes that may enter the board at this point. R18 helps to maintain a low impedance on U2D output line. The capacitor voltage indication (VCAP) is sent to A2A2 for use in determining the defibrillator's state of charge, and also to U1 pin 1 which will disable charging in the event that A2C1 voltage reaches an unacceptably high level.

2-24. PATIENT CIRCUITS (figure 6-1)

The patient circuitry functions to store energy during defibrillator charging; and to switch and waveshape the energy delivered to the patient during defibrillator discharge.

The patient is electrically isolated from A2A3 High Voltage Charger CCA and the High Voltage Capacitor (A2C1) at all times except during discharge. The charging circuit is isolated from A2C1 and from the patient during defibrillator discharge.

The patient circuit consists of:

- High Voltage Capacitor (A2C1).
- Patient Relay (A2K1).
- High Voltage Inductor (A2L1).

2-25. High Voltage Capacitor A2C1

A2C1 has a nominal value of 54 μF, and is not normally charged to more then about 4,000 volts. A2C1 includes a 24.9MΩ bleeder resistor across its terminals at all times, to preclude a buildup of charge if A2A3 is disconnected from the circuit.

2-26. Patient Relay A2K1

A2K1 is a double pole, double throw, high voltage, high surge current relay. The two common terminals are connected to A2C1, the two normally closed terminals are connected to A2A3, and the two normally open terminals are connected to the External Paddles (A3A1 and A3A2) through A2L1. The relaxed position of the relay connects A2C1 to the charging circuit. RF chokes are included as part of A2K1 to help suppress electromagnetic interference during high energy arcing of the contacts.

2-27. High Voltage Inductor A2L1

The High Voltage Inductor provides smoothing of the current waveform to meet specified AAMI parameters. In addition, 11Ω of winding resistance provides energy dissipation in the event that the defibrillator is discharged into a low external impedance.

2-28. A2A1 POWER SUPPLY CCA

The A2A1 Power Supply Assembly is capable of converting a 47 to 63 Hz AC input, between 103 and 253 volts, to a low ripple +14.3 volt DC output with a maximum output current capability of approximately 8 A. The supply is a high efficiency switching type, with an operating frequency of about 100 kHz. It is used as the primary power source for the defibrillator whenever acceptable AC power is available, with or without a battery installed.

If the AC line voltage is too low to allow A2A1 to provide the expected +14.3 V, a POWERFAIL signal is activated. The POWERFAIL signal is used by the DC-DC circuits on the A2A2 Control CCA to open A2A2K401 and isolate A2A1.

The Power Supply CCA is not repairable and contains no replaceable parts.

2-29. BT1 BATTERY ASSY (figure 6-1)

The Battery Assembly consists of a sealed, six cell lead acid type battery with a storage capacity of 2.9 Amp-hours at 12 volts (nominal). With a full charge, the battery is capable of providing at least 30, - 360 Joule charge/discharge cycles.

There are three wires exiting the battery assembly. Two are connected to the positive, and one is connected to the negative side of the battery. A nonrecoverable thermal fuse is in series with one of the positive wires. It is designed to disconnect the battery from the charging circuit at a still safe, through high, temperature. The other positive wire is only used to sense battery voltage and does not carry large current.

The battery assembly has a hose fitting which vents through a flexible tube to the front panel. In the event of a malfunction, where hydrogen is generated within the cells, the tube vents the hydrogen out of the enclosure.

2-30. A3 FRONT PANEL ASSEMBLY

The A3 Front Panel Assembly consists of the plastic front panel, and the components that mount to it. Electrically it can be broken down into seven major assemblies/circuits.

- A3A1 Apex Paddle Assembly.
- A3A2 Sternum Paddle Assembly.
- A3A3 Display CCA.
- A3A4 Membrane Switch Assembly.
- Speaker (SP1).
- Internal Test Load.
- AC Line Cord (P19).

2-31. A3A1 Apex Paddle (figure 6-8)

The Apex paddle provides a means to couple the defibrillators stored energy to the patient as well as one discharge request switch, a charge request switch, and a charge done LED.

The Apex paddle cable connects to two places internal to the defibrillator.

> The high voltage main conductor connects directly to A2L1.
>
> Five other low voltage signal (PAD DISCHG SW, PAD CHG LED, APEX DISCHG SW, DGND, and PAD CHG SW) conductors connect to A2A2 via J7.

Both charge and discharge switches share a common signal line. The charge done LED's current is returned on the shield, which is connected to digital ground on A2A2. Battery voltage is available on APEX DISCHG SW only if the Sternum discharge switch is pressed. If both paddles discharge switches are pressed, battery current flows through the Sternum switch, then through the Apex switch and then is available at PAD DISCHG SW.

NOTE

Refer to Control CCA (controller circuits) theory for additional information about detecting paddles switch.

2-32. A3A2 Sternum Paddle Assembly (figure 6-9)

The Sternum paddle provides a means to couple the defibrillators stored energy to the patient, as well as one discharge request switch.

The Sternum paddle cable connects to two places internal to the defibrillator.

> The high voltage main conductor connects directly to the A2K1.
>
> Three other low voltage signal (DGND, SWBATT, and STERNUM DISCHG SW) conductors connect to A2A2 via J8. The digital ground (DGND) is used to provide an electrical shield within the coil cord. SWBATT provides battery voltage to one side of the discharge switch. STERNUM DISCHG SW is the other side of the discharge switch.

When the discharge switch is pressed, battery current can flow through the switch to the other side (STERNUM DISCHG SW). There is one discharge switch in each paddle. The two switches are connected in series, so that both must be pressed before battery voltage is applied to the high side of A2K1. In addition, A2A2 must sense that both switches are pressed before A2K1 will be activated.

NOTE

Refer to A2A2 Control CCA (controller circuits) theory for additional information about detecting paddles switch.

2-33. A3A3 Display CCA (figure 6-3)

The A3A3 Display CCA is a printed circuit assembly consisting of three 7 segment displays and three LEDs.

The seven segment displays (DS4-DS6) are common cathode type with an integral decimal point on the right side. The common cathode for each display is brought out on a separate connector circuit (P1C). The anodes for the segments a-g and the decimal point on all three LED displays are bussed together (P1B).

The LEDs (DS1-3) are connected directly to independent circuits on connector (P1A).

2-34. A3A4 Membrane Switch Assembly (figure 6-1)

The Membrane Switch Panel Assembly is a combination label and switch circuit that mounts into the front panel of the defibrillator.

10 normally open switches are provided (ON/DISARM, OFF/RECHARGE, 40, 70, 100, 200, 300, 360, SYNC, and SYNC) to control defibrillator operations. The switches are a domed membrane type with screened conductive surfaces. Depressing a switch will cause the resistance between the corresponding terminal and the terminal labelled SW COM to be less then 250Ω.

NOTE

For more information about how switch presses are detected, refer to Control CCA theory.

2-35. A3SP1 Speaker (figure 6-1)

The A3SP1 Speaker (beeper) is used to audibly signal the user of various conditions. The 8Ω speaker is physically mounted on the front panel. It outputs an audible tone with a fundamental frequency of 976 Hz. The drive signal for the beeper is connected to the drive signal from A2A2 via J6.

2-36. Internal Test Load (figure 6-1)

Provides a means to test the basic operation of the defibrillator without additional equipment. The internal test load simulates a discharge into 50Ω. The test load is connected between the two paddles when they are inserted into their storage pockets. The test load consists of a 50Ω high power tapped resistor and neon lamp. A portion of the energy delivered to the test load is tapped off through a 1kΩ resistor and will flash the neon lamp when at least 100 joules is delivered.

2-37. A3P19 AC Line Cord (figure 6-1)

Standard three wire hospital grade cable is connected within the instrument directly to A2A1.

3-1. INTRODUCTION

This section describes the Checks and Adjustments that may need to be performed from time to time, or after a major repair. Checks and Adjustments are provided in four parts.

A. BATTERY VOLTAGE CHECK

B. LEVEL II PERFORMANCE CHECKS

C. SAFETY AND MAINTENANCE CHECKS

D. ADJUSTMENTS

A. BATTERY VOLTAGE CHECK

3-2. READ BATTERY VOLTAGE

Battery voltage should be checked weekly as follows:

1. Disconnect the AC power cord.
2. Press the POWER ON/DISARM key.
3. Press and hold the POWER ON/DISARM and right-hand SYNC key at the same time.
4. Verify the ENERGY-JOULES display reads ~13.0.

NOTE

Low Battery warning message comes on at ~11.8 V, and low battery shutdown occurs at ~11.2 V.

5. Reconnect the AC power cord, repeat steps 1-3, and verify the ENERGY-JOULES display reads ~14.3.

NOTE

~14.3 V indicates the battery charger is working normally.

B. LEVEL II PERFORMANCE CHECKS

Perform these checks every six months. For best results, use the equipment recommended. Record the defibrillator serial number and the date the checks were performed.

Table 3-1. Required Test Equipment for Performance, Safety and Maintenance Tests

REQUIRED TEST EQUIPMENT FOR LEVEL II PERFORMANCE, SAFETY and MAINTENANCE TESTS

REQUIREMENT	**NECESSARY QUALIFICATIONS**
MONITOR-RECORDER MODULE Recommend: HP 43200MD	No substitute.
DIGITAL VOLTMETER Recommend: HP 3468A	Capable of 5 to 15 Vdc ±1% measurements.
OHMMETER	Capable of 0.1 to 10Ω ±2% measurements.
ENERGY METER Recommend: Dynatech Nevada 429A	Capable of 5 to 400 Joule, critically damped sinusoidal waveform measurements with ±2% of full scale accuracy. Load resistance 50Ω ±0.5%.
STOPWATCH OR TIMER	Capable of measuring 2 to 12 second events with hand start/stop actuation to 1/4 sec. accuracy.
PATIENT ECG SIMULATOR Recommend: Dynatech Nevada ECG100	Output Level: High level CAL or ECG 0.5 to 5 volts outputs.
SAFETY ANALYZER Recommend: Dynatech Nevada 431F	No Substitute.
SIGNAL GENERATOR Recommend: HP 8111A	Sinewave, 1 to 5 Vp-p at 5 Hz.

3-3. TEST EQUIPMENT

Test equipment required for performing the level II performance, safety and maintenance checks is listed in Table 3-1. Test equipment characteristics and a recommended commercial model are included. If the recommended model is not available, select another with similar characteristics and capabilities.

WARNING

LETHAL VOLTAGES ARE PRESENT INSIDE THE DEFIBRILLATOR MODULE AND ARE EXPOSED WHEN THE DEFIBRILLATOR IS REMOVED FROM THE CASE. DO NOT WORK INSIDE THE INSTRUMENT WHEN POWER IS APPLIED OR IF DEFIBRILLATOR IS CHARGED.

3-4. ENERGY ACCURACY

Connect the Equipment as shown in Figure 3-1.

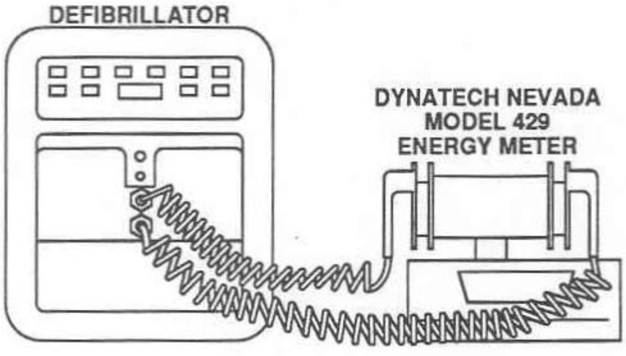


Figure 3-1. Energy Accuracy Test Setup.

1. Press the POWER ON/DISARM key.
2. Press the ENERGY SELECT/CHARGE 40 key and allow the unit to charge. Verify the CHARGE DONE tone sounds and the Apex paddle CHARGE DONE indicator lights when the unit is ready to discharge.
3. Firmly press the paddles to the energy meter. Press both DISCHARGE buttons simultaneously, and verify the Energy Meter reads from 34-46 joules. Record the energy level measured.
4. Using table 3-2, repeat steps 2 and 3 performing all energy levels. Compare the delivered energy levels indicated on the Energy Meter with the information below and verify all readings are within specified limits.

Table 3-2. Delivered Energy Accuracy.

Energy Selected	Delivered Energy (Joules)	
40	34-46	______________
70	60-80	______________
100	85-115	______________
200	170-230	______________
300	255-345	______________
360	306-414	______________

5. Press POWER OFF/RECHARGE key and disconnect test equipment.

3-5. SELF-TESTING ACCURACY

1. Press the POWER OFF/RECHARGE key.
2. Verify the paddles and the paddle contacts in the storage pockets are clean and free of contaminants.
3. Place the paddles firmly in their storage positions with the Apex on the right side and Sternum on the left side.
4. Press the POWER ON/DISARM key.
5. Press the ENERGY SELECT 100J/Test key. Verify unit charges and the display indicates 100.
6. Firmly press the paddles to their storage positions, press both DISCHARGE buttons simultaneously, and verify the neon TEST lamp located between the paddles flashes.
7. Press the POWER OFF/RECHARGE key.

3-6. DEFIBRILLATOR CAPACITOR CHARGE TIME.

1. Press the POWER OFF/RECHARGE key.
2. Disconnect the AC power cord from AC power source.
3. Press the POWER ON/DISARM key.
4. Read the battery voltage (paragraph 3-2).
    - If the battery is above 12.3 volts proceed with step 5.
    - If the battery is below 12.3 volts, allow it to fully charge by plugging into an AC source for 8 hours or more.
5. Press the ENERGY SELECT 360 key, and using a Stopwatch, verify unit charges and display indicates 360 in less than 10 seconds.
6. Press the POWER OFF/RECHARGE key.

3-7. SYNCHRONIZER

1. Press the POWER ON/DISARM key. Verify Monitor-Recorder module is not connected, or if connected, verify the Monitor-Recorder module POWER is OFF.
2. Simultaneously press both SYNC keys and verify:
    - The SYNC indicator flashes one time then goes out.
    - ENERGY-JOULES display flashes "EEE" one time.
3. Connect a Monitor-Recorder module (using optical link) and press the POWER ON key.
4. Simultaneously press both SYNC keys and verify:
    - The Defibrillator SYNC indicator lights.
    - The Monitor-Recorder CRT screen displays "USE LEADS" and SYNC.
5. Press the ENERGY SELECT 40 key. Verify unit charges and the display indicates 40.
6. Firmly press the paddles to their storage positions, and verify the Monitor-Recorder CRT screen displays a flat baseline (no ECG). Press both DISCHARGE buttons simultaneously, and verify the unit DOES NOT discharge. Release both DISCHARGE buttons.
7. Press the POWER ON/DISARM key. Verify unit disarms and the display counts down to 0.
8. Connect the Equipment as shown in Figure 3-2.

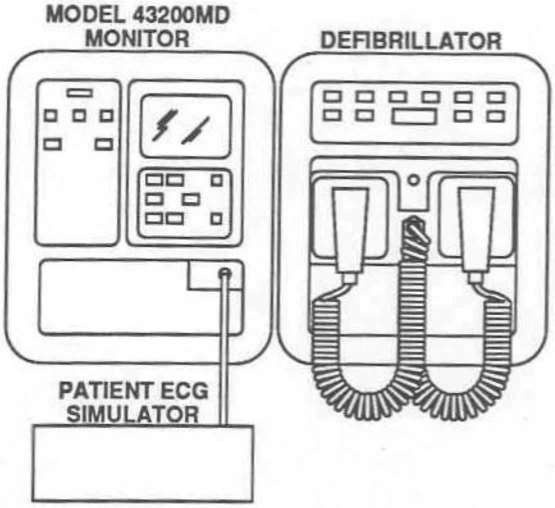


Figure 3-2. Synchronizer Test Setup.

9. Verify Patient ECG Simulator is connected to the Monitor-Recorder module lead input. Press the Monitor-Recorder module LEAD SELECT key until lead II is displayed on the CRT screen. Adjust Patient ECG Simulator until an ECG waveform is displayed on the Monitor-Recorder module CRT screen. Verify a bright dot appears on each QRS waveform (monitor CRT screen) and the SYNC indicator (defibrillator) flashes.
10. Press the ENERGY SELECT 40 key. Verify unit charges and the display indicates 40.
11. Firmly press the paddles to their storage positions. Press both DISCHARGE buttons simultaneously, and verify the unit discharges on the next detected systole.
12. Press both the the Defibrillator and Monitor-Recorder modules POWER OFF/RECHARGE keys.
13. Disconnect test equipment.

C. SAFETY AND MAINTENANCE CHECKS

Perform these checks every six months or after a major repair.

NOTE

Make these initial checks before performing the safety tests.

1. Check that paddle electrodes (both pediatric and adult) are in good condition, clean and not pitted. Check for obvious cracks (small-chips, gouges and scratches are acceptable and will not affect instrument performance). Check cable strain reliefs for cracks or other signs of deterioration at the paddles.
2. Check that the Apex paddle CHARGE button will initiate charge and DISCHARGE buttons function when the cables are stretched to their full length. Check that discharge only occurs when both buttons are simultaneously pressed.

CAUTION

Paddles must be discharged into 50Ω.

3-8. POWER CORD TO CHASSIS GROUND RESISTANCE CHECK

1. Press the POWER OFF/RECHARGE key and disconnect the AC power cord. Connect the test equipment as shown in Figure 3-3.
2. Connect the dual banana plug of a Kelvin Cable between the LO meter terminal of the Safety Analyzer and the – (negative) terminal of the 1/2 amp source on the Safety Analyzer.
3. Connect the clip on the other end of the Cable to the ground pin of the Defibrillator module male power connector.
4. Connect the dual banana plug of the second Kelvin Cable between HI terminal of the meter section and the + (positive) terminal of the 1/2 amp source.
5. Connect the clip on the other end to a banana/banana cable inserted in the external ground jack on the front of the Defibrillator module.
6. Press MILLIOHMS and read the resistance on the current ranges. Verify the readings is less than or equal to 0.20Ω.
7. Disconnect test equipment.

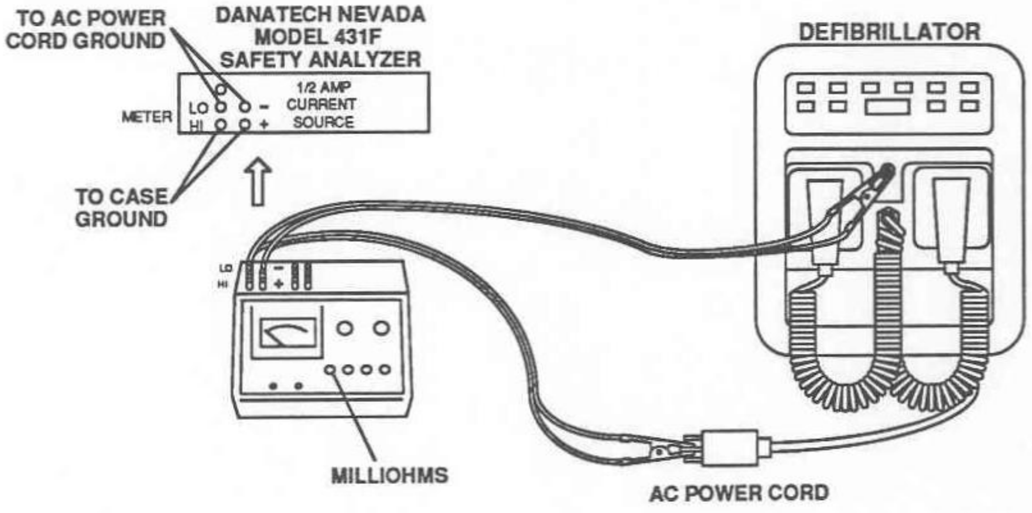


Figure 3-3 Power Cord to Chassis Ground Resistance Check.

3-9. PADDLE LEAKAGE CURRENT (SOURCE LEAKAGE) TO GROUND

1. Connect the test equipment as shown in Figure 3-4.

NOTE

Use clip leads to connect the right paddle to the RA output of the Safety Analyzer and the left paddle to the LA output.

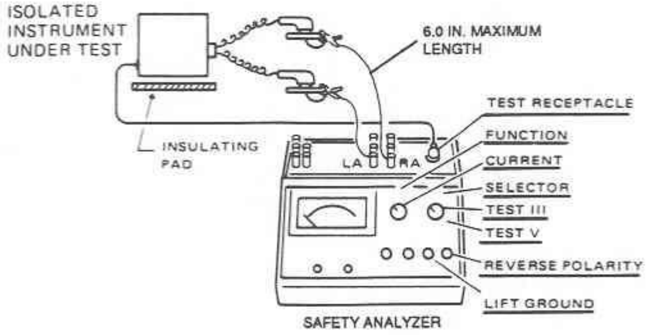


Figure 3-4. Paddle Leakage Current Test Setup.

2. Set the Safety Analyzer FUNCTION switch to CURRENT. (Set the SELECTOR switch to either RA or LA to test either paddle. For paddle-to-paddle checks, ground either paddle and test the other.)
3. Measure paddle source leakage to ground for each paddle individually. Verify current is no more than 100 µA for all conditions.
4. Repeat steps 1 through 4 under each of the following conditions, with the power set both ON and OFF.

WARNING

MAKE ALL PADDLE TEST HOOKUP CONNECTIONS BEFORE PERFORMING THE FIFTH (e) CHECK (live paddles). KEEP PADDLES SEPARATED ON INSULATED PAD DURING TEST.

CONDITIONS:

a. Chassis grounded, standard power polarity.

b. Chassis grounded, reverse power polarity.

c. Chassis ungrounded, standard power polarity.

d. Chassis ungrounded, reverse power polarity.

e. Defibrillator charged to 360J. (see warning above)

CAUTION

Discharge defibrillator by pressing POWER OFF/RECHARGE key. ***DO NOT PRESS DISCHARGE BUTTONS.***

5. Press POWER OFF/RECHARGE key.

3-10. PADDLE LEAKAGE CURRENT (SINK CURRENT) WITH 115 VOLTS APPLIED

1. Connect the test equipment as shown in Figure 3-4.
2. Set Safety Analyzer FUNCTION switch to CURRENT.
3. Press the red 115 V test button under each of the following conditions with the power ON and OFF. Verify current is no more than 100 µA for all conditions.

CONDITIONS:

a. Chassis grounded, standard power polarity.

b. Chassis grounded, reverse power polarity.

4. Press POWER OFF/RECHARGE key and disconnect test equipment.

D. ADJUSTMENTS

Internal adjustments are made at the factory and normally do not require attention. However, if assemblies are repaired or replaced, check and adjust as necessary.

All test equipment necessary to make the adjustments is listed in each Adjustment Procedure.

The instrument case must be opened to gain access to the adjustment controls. Refer to Section IV as required.

3-11. DEFIBRILLATOR OUTPUT ENERGY CALIBRATION

This is for adjustment of the output energy on discharge. Adjustment location is on the A2A2 Control CCA (figure 6-5).

Equipment Required:

Energy Meter Recommended Dynatech Nevada 429A	Capable of 2 to 400 Joule measurement with critically damped sinusoidal waveform. Accuracy +/– 2% of full scale Load resistance 50Ω +0.5%

Procedure:

NOTE

Refer to figure 3-1 for test equipment hook-up, if necessary.

1. Press the POWER ON/DISARM key.
2. Press the ENERGY SELECT/CHARGE 100J/TEST key and allow the unit to charge. Verify the CHARGE DONE tone sounds and the Apex paddle CHARGE DONE indicator lights when the unit is ready to discharge.
3. Firmly press the paddles to the energy meter contacts, and press both DISCHARGE buttons simultaneously.
   - Adjust the HV capacitor voltage signal by adjusting A2A2R119 (VCAP) if necessary, to obtain proper delivered energy.
4. Press the ENERGY SELECT/CHARGE 360 key and allow the unit to charge. Verify the CHARGE DONE tone sounds and the Apex paddle CHARGE DONE indicator lights when the unit is ready to discharge.
5. Firmly press the paddles to the energy meter contacts, and press both DISCHARGE buttons simultaneously.
   - Adjust A2A2R119 (VCAP) if necessary, to obtain proper delivered energy.
6. Using table 3-3, perform all energy levels. Compare the delivered energy levels indicated on the Energy Meter with the information below and verify all readings are within specified limits.

Table 3-3. Delivered Energy Accuracy.

Energy Selected	Delivered Energy (Joules)	
40	40-46	______
70	70-80	______
100	100-115	______
200	200-230	______
300	300-345	______
360	360-414	______

7. If readings are incorrect, repeat steps 1 to 6.
8. Press POWER OFF/RECHARGE key and disconnect test equipment.

3-12. ECG GAIN ADJUSTMENT

This is for adjustment of the ECG Gain Amplifier. Adjustment location is on the A2A2 Control CCA (figure 6-5).

Equipment Required:

Signal Generator	Capable of 3Vp-p at 5 Hz sinewave.
Fixed Resistors	(1) 100kΩ and (1) 100Ω, ±1%.
Monitor-Recorder	HP 43200MD (no substitute).

Procedure:

1. Properly connect a Monitor-Recorder module (using optical link) and press the POWER OFF/RECHARGE key.
2. Press Defibrillator POWER ON/DISARM key.
3. On the Monitor-Recorder Module:
   - Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a triangle waveform followed by a stair step waveform.
   - Verify BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "GAIN xxxx a" is displayed on the CRT screen.

4. Press SELECT key until ECG SIZE indicator is on. Press the UP or DOWN arrow keys until "GAIN 1000" is displayed on the CRT screen.
5. Press SELECT key until BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "NOISE x.xxv" is displayed on the CRT screen.
6. Connect the Signal Generator and resistors as shown in figure 3-5.
7. Adjust Signal Generator output to 3.0Vp-p at 5Hz sinewave.
8. Adjust A2A2R331 "GAIN" until CRT screen reads NOISE 3.00v (2.90 to 3.10).
9. Press POWER OFF/RECHARGE key and disconnect test equipment.

3-13. ECG OFFSET ADJUSTMENT

This is for offset adjustment of the ECG Gain Amplifier. Adjustment location is on the A2A2 Control CCA (figure 6-5).

Equipment Required:

Monitor-Recorder	HP 43200MD (no substitute).

Procedure:

1. Properly connect a Monitor-Recorder module (using optical link) and press the POWER OFF/RECHARGE key.
2. Press Defibrillator POWER ON/DISARM key.
3. On the Monitor-Recorder Module:
   - Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a triangle waveform followed by a stair step waveform.
   - Verify BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "GAIN xxxx a" is displayed on the CRT screen.
4. Press SELECT key until ECG SIZE indicator is on. Press the UP or DOWN arrow keys until "GAIN 4000" is displayed on the CRT screen.
5. Press SELECT key until BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "OFFST x.xxv" is displayed on the CRT screen.
6. Leave paddles installed in their storage positions (Apex on right, Sternum on left).
7. Adjust A2A2R328 "OFFSET" until CRT screen reads OFFST 0.00v (<0.50) with trace centered.
8. Press POWER OFF/RECHARGE key and disconnect test equipment.

3-14. POWER SUPPLY ADJUSTMENT

There are no field adjustments for the A2A1 Power Supply CCA.

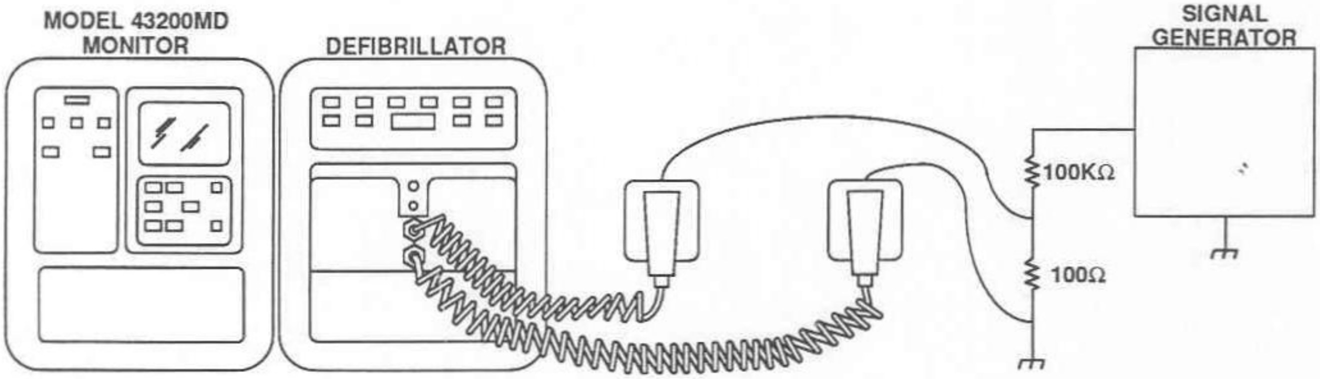


Figure 3-5. ECG Gain Adjust.

4-1. INTRODUCTION

This section describes the procedures used to remove and replace the following items:

- Defibrillator Module (from case).
- Battery Assembly (BT1).
- Infrared Link Circuit Card Assembly (CCA) (A1A1).
- Chassis Assembly (A2).
- Power Supply Circuit Card Assembly CCA (A2A1).
- Control CCA (A2A2).
- High Voltage (HV) Capacitor Charger CCA (A2A3).
- High Voltage Capacitor (A2C1).
- Patient Relay (A2K1).
- High Voltage Inductor (A2L1).
- Front Panel Assembly (A3).
- Apex Paddle Assembly (A3A1).
- Sternum Paddle Assembly (A3A2).
- Display CCA (A3A3).
- Membrane Switch Assembly (A3A4).
- Paddle Disassembly.

Illustrations are provided at the end of this section to identify all the items referenced (both by name and reference designator) in the following procedures.

- Defibrillator Front View - figure 4-1.
- Defibrillator Rear View - figure 4-2.
- Defibrillator Top View - figure 4-3.
- Defibrillator Right Side View - figure 4-4.
- Defibrillator Left Side View - figure 4-5.
- Paddle Exploded View - figure 4-6.

Reverse disassembly instructions to reassemble. Use the torque chart listed below when re-tightening hardware.

No. 2 Screw	2 in-lbs
No. 4 Screw	6 in-lbs
No. 6 Screw	8 in-lbs
No. 6 Screw with rubber washer	6 in-lbs
No. 8 Screw	12 in-lbs
No. 8 Plastic standoff	2 in-lbs
Strain relief on AC power cord	10 in-lbs

4-2. DEFIBRILLATOR MODULE.

WARNING

DISCONNECT THE DEFIBRILLATOR FROM THE A.C. POWER SOURCE BEFORE PROCEEDING.

THIS UNIT IS BATTERY POWERED, CAUSING DANGEROUS VOLTAGES TO BE PRESENT EVEN WITH AC POWER SOURCE REMOVED.

1. Disconnect AC power cord from AC source.
2. Press the POWER OFF/RECHARGE key.
3. Remove 18 screws and washers holding Defibrillator module front panel.
4. Slide Defibrillator module out of case enough to disconnect A1A1 IR Link CCA 10 pin ribbon cable A1A1P36 from the A2A2 Control CCA.
5. Remove Defibrillator module.
6. Disconnect three pin battery cable BT1P14.

4-3. BATTERY ASSEMBLY (BT1).

1. Remove defibrillator module from case (paragraph 4-2).
2. Working from rear, disconnect three pin cable BT1P14 and battery vent tube.
3. Remove two screws and washers, and battery retainer.
4. Remove BT1 Battery Assembly.
5. When installing the Battery Assembly, make sure the vent hole and BT1P14 are on the proper side. Reconnect battery vent tube.

4-4. INFRARED LINK CCA (A1A1).

1. Remove defibrillator module from case (paragraph 4-2).
2. Working from inside the case, remove two screws and washers.
3. Remove A1A1 Infrared Link CCA.
4. When installing A1A1 Infrared Link CCA, make sure 10 pin ribbon cable A1A1P36 is positioned on top and components are facing towards window.

4-5. CHASSIS ASSEMBLY (A2).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected. Disconnect vent tube.
3. Disconnect the following wires (tag before disconnecting if necessary):
    - 16 pin ribbon cable A3A3P1 (A2A2J1).
    - 11 pin ribbon cable A3A4P2 (A2A2J2).
    - 2 pin speaker cable A3P6 (A2A2J6).
    - 5 pin cable A3A1P7 (A2A2J7).
    - 4 pin cable A3A2P8 (A2A2J8).
    - 3 pin cable A3P19 (A2A1-3 pin connector).
    - White wire (top terminal lug - to A2A2P10).
    - White wire (top terminal lug - to HV Inductor A2L1).
    - Red wire (bottom terminal lug - to A2A2P11).
    - Red wire (bottom terminal lug - to Patient Relay A2K1).
4. Remove three nuts and washers holding Green/Yellow ground wires (one on side, two on back). Disconnect Green/Yellow ground wires (A3P19, P25, and P28).
5. Verify that all the cables and wires are clear from retaining clamps and wraps.
6. Remove six nuts and washers holding A2 Chassis Assembly to A3 Front Panel Assembly.
7. Separate A2 Chassis Assembly from A3 Front Panel Assembly.
8. When installing the A2 Chassis Assembly, make sure the cables and wires are routed in the proper holes, clamps, and wraps. Reconnect battery vent tube.

4-6. POWER SUPPLY CCA (A2A1).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected. Disconnect vent tube.
3. Remove A2A2 Control CCA (paragraph 4-7).
4. Remove A2 Chassis Assembly (paragraph 4-5).
5. Remove A2A3 HV Capacitor Charger CCA (paragraph 4-8).
6. Working from top, remove six screw in retainer posts and insulator plate.
7. Remove A2A1 Power Supply CCA.
8. When installing the A2A1 Power Supply CCA, make sure the insulator is in place. Reconnect battery vent tube.

4-7. CONTROL CCA (A2A2).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected.
3. Disconnect the following wires (tag before disconnecting if necessary):
    - 16 pin ribbon cable A3A3P1 (A2A2J1).
    - 11 pin ribbon cable A3A4P2 (A2A2J2).
    - 9 pin cable A2A3P4 (A2A2J4).
    - 3 pin cable A2K1P5 (A2A2J5).
    - 2 pin speaker cable A3P6 (A2A2J6).
    - 5 pin cable A3A1P7 (A2A2J7).
    - 4 pin cable A3A2P8 (A2A2J8).
    - 3 pin cable (A2A2P12) - disconnect from chassis.
    - 3 pin cable A2A2P13 (A2A1 7 pin connector).
    - White wire (top terminal lug - to A2A2P10).
    - Red wire (bottom terminal lug - to A2A2P11).
4. Remove one nut and washer holding Green/Yellow ground wire. Disconnect Green/Yellow ground wire.
5. Verify that all the cables and wires are clear from retaining clamps and wraps.
6. Pinch eight retainer posts and lift A2A2 Control CCA.
7. Separate A2A2 Control CCA from A2 Chassis Assembly.

8. When installing A2A2 Control CCA, make sure the cables and wires are routed in the proper holes, clamps, and wraps.

4-8. HIGH VOLTAGE CAPACITOR CHARGER CCA (A2A3).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected. Disconnect vent tube.
3. Remove A2 Chassis Assembly (paragraph 4-5).
4. Disconnect the following wires (tag before disconnecting if necessary):
    - 9 pin cable A2A3P4 (A2A2J4).
    - White wire (A2A3P15) from Patient Relay (A2K1).
    - White wire (A2A3P16) to HV Capacitor (A2C1 - rear terminal).
    - Red wire (A2A3P17) to A2C1 (front terminal).
    - Red wire (A2A3P18) from A2K1.
5. Working from top, remove two screws and washers, and circuit card retainer.

NOTE

It may be necessary to partially remove A2A2 Control CCA (paragraph 4-7) to access both screws.

6. Remove A2A3 HV Capacitor Charger CCA.
7. When installing the A2A3 HV Capacitor Charger CCA, position in place and replace circuit card retainer. Make sure the cables and wires are routed in the proper holes, clamps, and wraps. Reconnect battery vent tube.

4-9. HIGH VOLTAGE CAPACITOR (A2C1).

WARNING

Discharge High Voltage Capacitor (A2C1) with an insulated shorting bar before proceeding with removal procedures.

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected. Disconnect vent tube.
3. Remove A2 Chassis Assembly (paragraph 4-5).
4. Disconnect the following wires (tag before disconnecting if necessary):
    - White wire from Patient Relay (A2K1 (rear terminal).
    - White wire (A2A3P16) from A2A3 HV Capacitor Charger CCA (rear terminal).
    - Red wire (A2A3P17) from A2A3 (front terminal).
    - Red wire from A2K1 (front terminal).
5. Working from rear, remove two screws and washers, and both capacitor retainers.
6. Remove A2C1 HV Capacitor.
7. When installing A2C1 HV Capacitor, position in place with the black terminal shield facing towards the rear, and the red terminal shield facing towards the front. Make sure resistor (24.9MΩ) is across terminals. Reconnect battery vent tube.

4-10. PATIENT RELAY (A2K1).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected.
3. Disconnect the following wires (tag before disconnecting if necessary):
    - 3 pin cable A2K1P5 (A2A2J5).
    - Red wire connected to bottom terminal lug).
    - Red wire connected to HV Capacitor (A2C1) (front terminal).
    - Red wire (A2A3P18) from A2A3 HV Capacitor Charger CCA.
    - White wire connected to High Voltage Inductor (A2L1).
    - White wire connected to A2C1 (rear terminal).
    - White wire (A2A3P15) connected to A2A3.

4. Working from top, remove large nut and washer.
5. Remove A2K1 Patient Relay from bottom.
6. When installing A2K1 Patient Relay, make sure insulator is installed on bottom side.

4-11. HIGH VOLTAGE INDUCTOR (A2L1).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected.
3. Disconnect the following wires (tag before disconnecting if necessary):
    - White wire (center) connected to Patient Relay (A2K1).
    - White wire (top)connected to top terminal lug.
4. Working from rear, remove screw and washer.
5. Remove A2L1 High Voltage Inductor.
6. When installing A2L1 High Voltage Inductor, make sure small post is inserted in the upper mounting hole on the chassis.

4-12. FRONT PANEL ASSEMBLY (A3).

1. Follow procedures provided for A2 Chassis Assembly (paragraph 4-5).

4-13. APEX PADDLE ASSEMBLY (A3A1).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected. Disconnect vent tube.
3. Remove A3 Front Panel Assembly (paragraph 4-12).
4. Disconnect the following wires (tag before disconnecting if necessary):
    - White wire connected to top terminal lug.
5. Working from rear, remove large plastic nut. If necessary, loosen front strain relief to allow cable to slide back.
6. Feed cable through bottom hole and remove A3A1 Apex Paddle Assembly.
7. When installing A3A1 Apex Paddle Assembly:
    - Feed cable through BOTTOM hole.
    - If front strain relief was loosened, tighten AFTER nut is tightened.
    - Connect white wire to TOP terminal lug.
    - Reonnect battery vent tube.

4-14. STERNUM PADDLE ASSEMBLY (A3A2).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected. Disconnect vent tube.
3. Remove A3 Front Panel Assembly (paragraph 4-12).
4. Disconnect the following wires (tag before disconnecting if necessary):
    - Red wire connected to bottom terminal lug.
5. Working from rear, remove large plastic nut. If necessary, loosen front strain relief to allow cable to slide back.
6. Feed cable through top hole and remove A3A2 Sternum Paddle Assembly.
7. When installing A3A2 Sternum Paddle Assembly:
    - Feed cable through TOP hole.
    - If front strain relief was loosened, tighten AFTER nut is tightened.
    - Connect red wire to BOTTOM terminal lug.
    - Reconnect battery vent tube.

4-15. DISPLAY CCA (A3A3).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected. Disconnect vent tube.
3. Remove A3 Front Panel Assembly (paragraph 4-12).
4. Working from rear, remove three screws and washers.
5. Remove A3A3 Display CCA.

6. When installing A3A3 Display CCA, make sure indicators align with front panel holes. Reconnect battery vent tube.

4-16. MEMBRANE SWITCH ASSEMBLY (A3A4).

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected.
3. Disconnect 11 pin ribbon cable A3A4P2 (A2A2J2).
4. Working from front, peel A3A4 Membrane Switch Assembly and remove. Feed cable through square hole in front panel.
5. When installing new A3A4 Membrane Switch Assembly, make sure front panel surface is clean and dry.

4-17. PADDLE DISASSEMBLY.

1. Remove defibrillator module from case (paragraph 4-2).
2. Verify that 3 wire battery cable BT1P14 is disconnected.
3. Remove Paddle Assembly (Apex paragraph 4-13, or Sternum paragraph 4-14) ONLY if cable replacement is necessary.
4. Remove the paddle identification label on handle.
5. Remove two screws and washers. Slide cover forward and remove.
6. Disconnect the following wires as required (tag before disconnecting if necessary):
   - 5 pin wire - Switch CCA to cable.
   - Black wire - Cable to electrode.
   - 2 pin wire - Switch CCA to LED (Apex).
7. Remove as required:
   - Lift up and remove the Switch CCA. Take care not to loose actuator spring.
   - Remove the red DISCHARGE button and the actuator spring.
   - Remove cable assembly.
   - If APEX paddle, remove the red CHARGE button and spring.
   - If APEX paddle, remove the red LED.
8. Install as required:
   - If APEX paddle, install the red LED connector in hole and press LED retainer in place.
   - If APEX paddle, install spring into the red CHARGE button (end with two closed coils), then place button in paddle hole, spring facing in.
   - Install cable assembly in paddle slot.
   - Install the red DISCHARGE button with slope (short side) facing up.
   - Install the actuator spring with small end centered over post on actuator.
9. Reconnect the following wires as required:
   - Black wire - Cable to electrode.
   - 5 pin wire - Switch CCA to cable.
   - 2 pin wire - Switch CCA to LED (Apex).
10. Install the Switch CCA by aligning the CCA in the slots and press down. Compress actuator spring enough to clear tab on paddle housing. Release and make sure spring is centered on tab.
11. Install cover, and two screws and washers. Install a new paddle identification label on the handle.

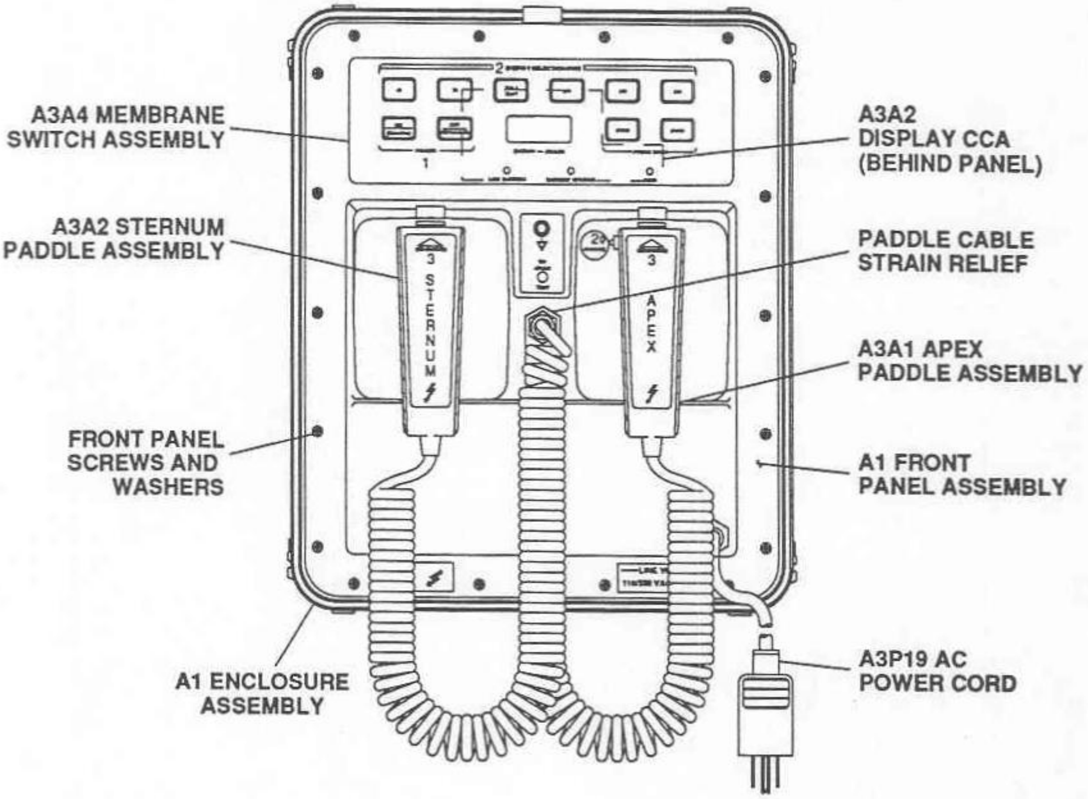

A3A4 MEMBRANE SWITCH ASSEMBLY
A3A2 STERNUM PADDLE ASSEMBLY
FRONT PANEL SCREWS AND WASHERS
A1 ENCLOSURE ASSEMBLY
A3A2 DISPLAY CCA (BEHIND PANEL)
PADDLE CABLE STRAIN RELIEF
A3A1 APEX PADDLE ASSEMBLY
A1 FRONT PANEL ASSEMBLY
A3P19 AC POWER CORD
STERNUM
APEX
3

Figure 4-1. Defibrillator Module Front View.

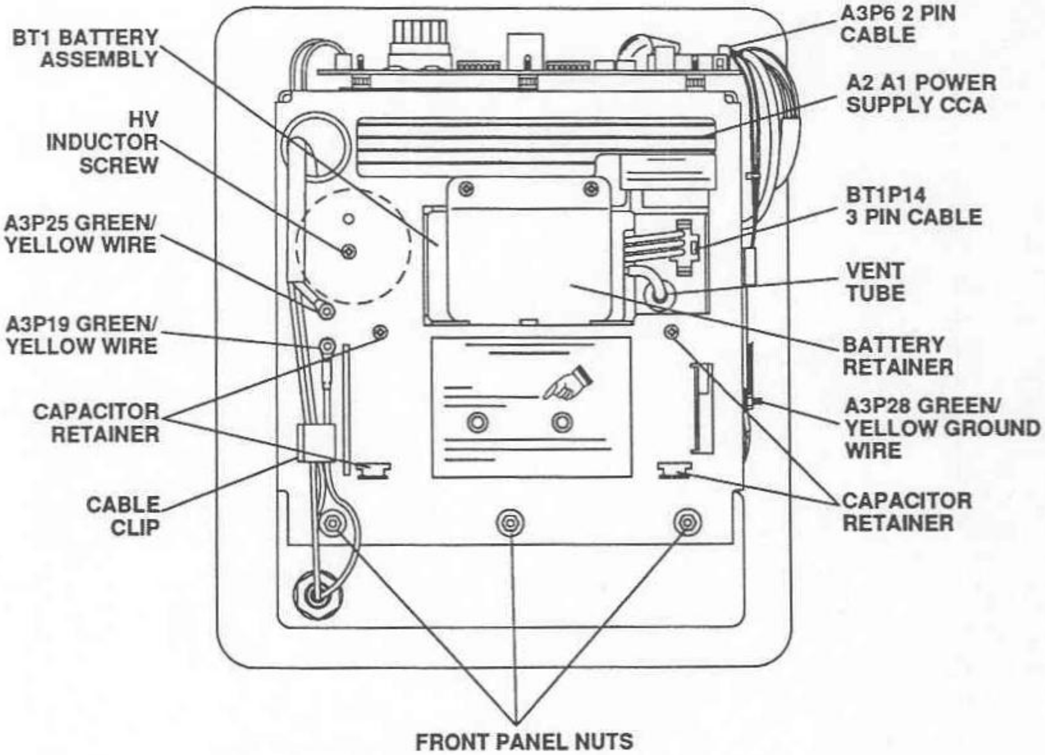

BT1 BATTERY ASSEMBLY
HV INDUCTOR SCREW
A3P25 GREEN/ YELLOW WIRE
A3P19 GREEN/ YELLOW WIRE
CAPACITOR RETAINER
CABLE CLIP
A3P6 2 PIN CABLE
A2 A1 POWER SUPPLY CCA
BT1P14 3 PIN CABLE
VENT TUBE
BATTERY RETAINER
A3P28 GREEN/ YELLOW GROUND WIRE
CAPACITOR RETAINER
FRONT PANEL NUTS

Figure 4-2. Defibrillator Module Rear View.

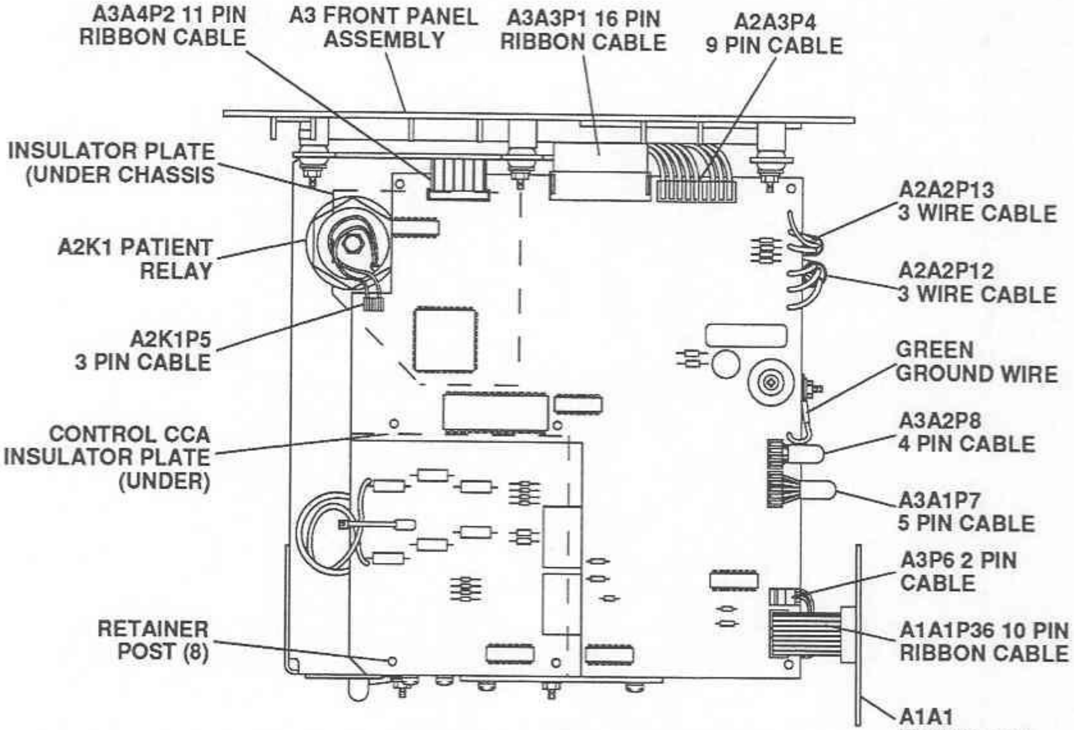

A3A4P2 11 PIN RIBBON CABLE
A3 FRONT PANEL ASSEMBLY
A3A3P1 16 PIN RIBBON CABLE
A2A3P4 9 PIN CABLE
INSULATOR PLATE (UNDER CHASSIS
A2K1 PATIENT RELAY
A2K1P5 3 PIN CABLE
CONTROL CCA INSULATOR PLATE (UNDER)
RETAINER POST (8)
A2A2P13 3 WIRE CABLE
A2A2P12 3 WIRE CABLE
GREEN GROUND WIRE
A3A2P8 4 PIN CABLE
A3A1P7 5 PIN CABLE
A3P6 2 PIN CABLE
A1A1P36 10 PIN RIBBON CABLE
A1A1 IR LINK CCA

Figure 4-3. Defibrillator Module Top View.

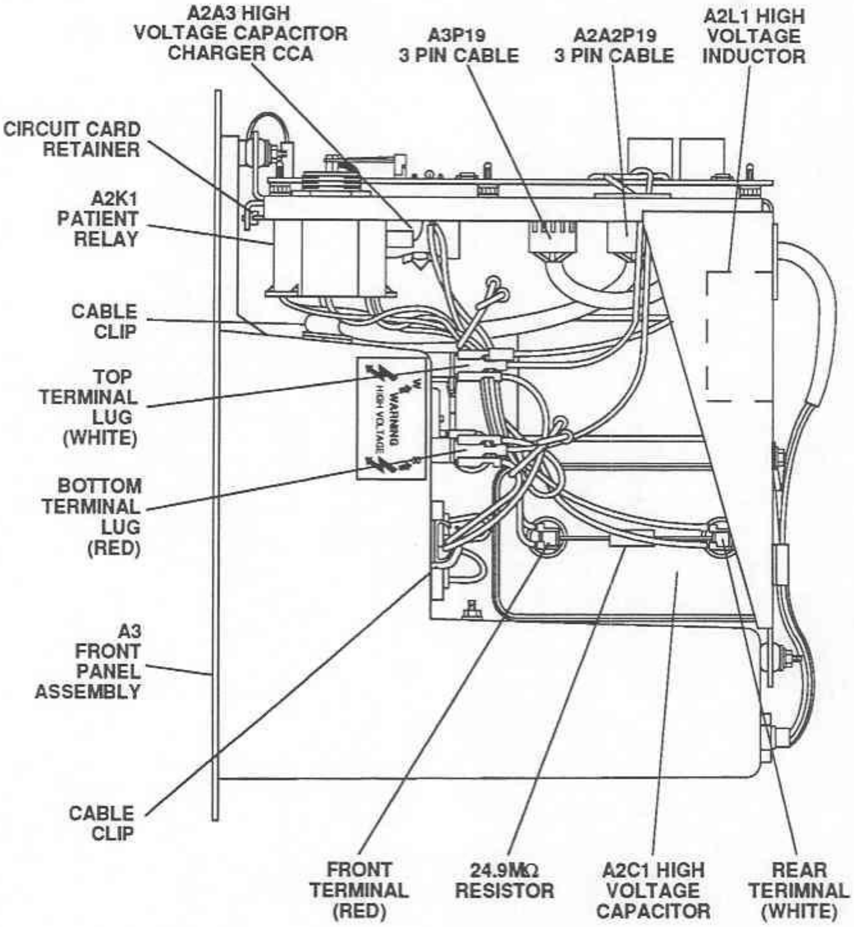

A2A3 HIGH VOLTAGE CAPACITOR CHARGER CCA
A3P19 3 PIN CABLE
A2A2P19 3 PIN CABLE
A2L1 HIGH VOLTAGE INDUCTOR
CIRCUIT CARD RETAINER
A2K1 PATIENT RELAY
CABLE CLIP
TOP TERMINAL LUG (WHITE)
BOTTOM TERMINAL LUG (RED)
A3 FRONT PANEL ASSEMBLY
CABLE CLIP
WARNING HIGH VOLTAGE
FRONT TERMINAL (RED)
24.9MΩ RESISTOR
A2C1 HIGH VOLTAGE CAPACITOR
REAR TERIMNAL (WHITE)

Figure 4-4. Defibrillator Module Right Side View.

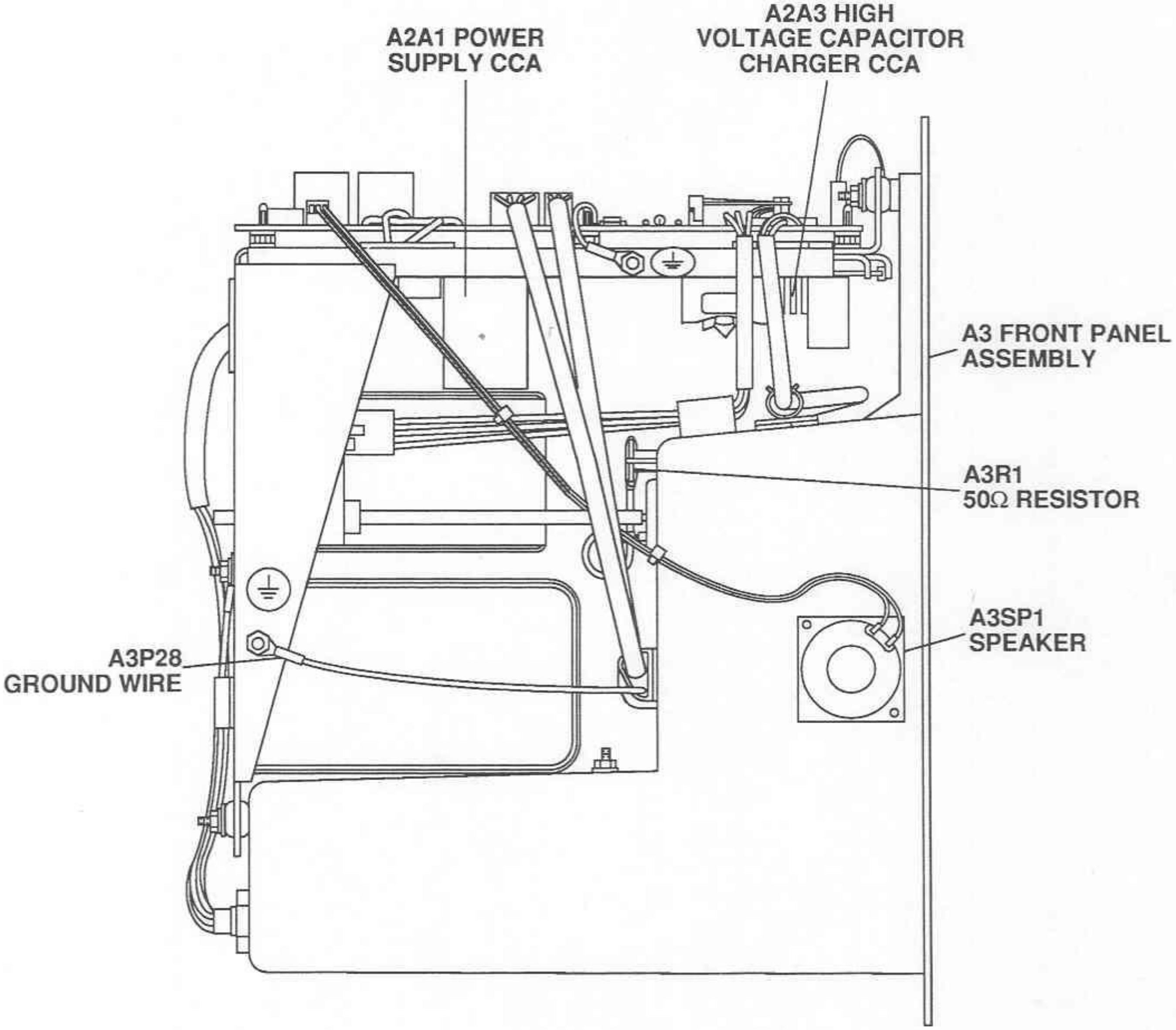

A2A1 POWER SUPPLY CCA
A2A3 HIGH VOLTAGE CAPACITOR CHARGER CCA
A3 FRONT PANEL ASSEMBLY
A3R1 50Ω RESISTOR
A3SP1 SPEAKER
A3P28 GROUND WIRE

Figure 4-5. Defibrillator Module Left Side View.

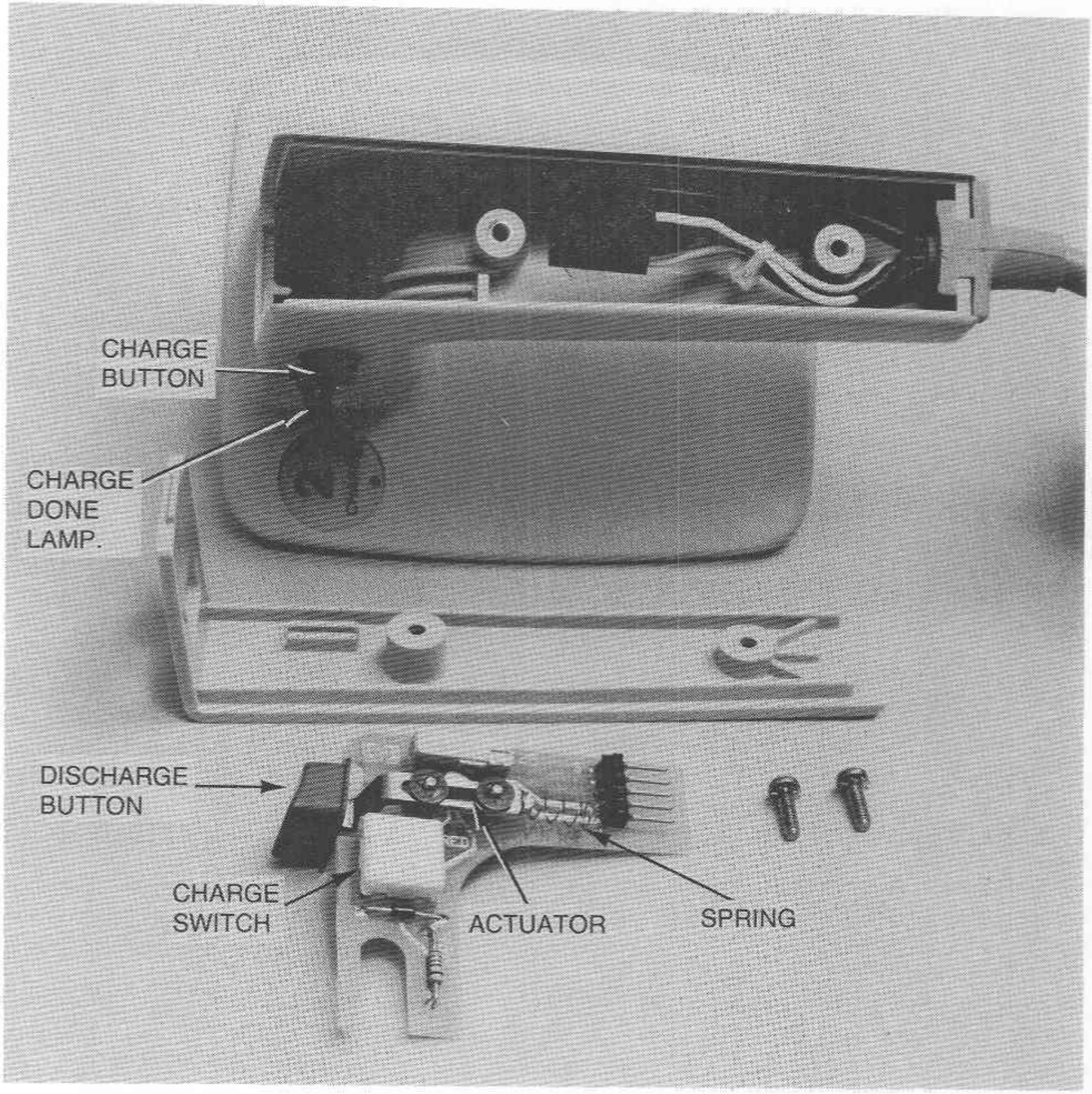

CHARGE BUTTON
CHARGE DONE LAMP.
DISCHARGE BUTTON
CHARGE SWITCH
ACTUATOR
SPRING

Figure 4-6. Paddles Exploded View.

5-1. INTRODUCTION

This section describes the procedures used to troubleshoot the Defibrillator module. Other sections in the manual that will help in diagnosis of a malfunction are as follows:

- Section II - Theory of Operation. Contains information about circuit theory down to individual piece part levels. Schematic diagrams are referenced directly out of theory for ease of use in troubleshooting.
- Section III - Checks and Adjustments. Contains information about proper performance parameters and also post repair adjustments.
- Section VI - Replaceable Parts. Contains the necessary functional block diagrams, schematic diagrams, and component locators. Also contains voltages and waveforms necessary for troubleshooting.

5-2. TROUBLESHOOTING GUIDELINES.

The following is a list of aids that you can use when troubleshooting the Defibrillator Module:

- Check all forms and tags attached to, or accompanying, the equipment to determine the reason for removal from service.
- The Defibrillator Module will display error codes for use in troubleshooting.
- Most problems in troubleshooting the Defibrillator Module will be logical, i.e., if the display doesn't work the problem is likely on the Display Circuit Card Assembly (CCA), or the Control CCA, etc.
- All functions rely on proper power, so remember to verify all operating voltages.
- Refer to the theory of operation (Section II) as required. This provides circuit theory of the section you are troubleshooting with references to the detailed functional and schematic diagrams.
- Circuit cooler spray can be used in isolating problems. The most generally used method is to spray suspected circuits/components to see if the malfunction can be temporarily fixed. This method will not work all the time, but it can be a great timesaver. It is especially helpful on intermittent problems that get worse with a rise in temperature.
- Problems on Defibrillator Modules that have been in service for awhile may be caused by corrosion. Sometimes removing and reseating the affected cable will correct a malfunction. Cleaning connector pins and/or switch contacts with alcohol will repair many types of digital and analog circuit malfunctions.
- For microcircuit orientation, pin one is identified by a square solder pad on the printed circuit board.

5-3. EQUIPMENT INSPECTION.

The following inspection procedures shall be used to locate obvious malfunctions in the Defibrillator Module.

- Remove Defibrillator Module from case (Section IV, paragraph 4-2) as required to access components.
- Inspect all external surfaces of Defibrillator Module for physical damage, breakage, loose or dirty contacts, and missing components.

WARNINGS

Defibrillator Module contains high voltages. After power is removed, discharge capacitors to ground before working inside to prevent electrical shock.

Disconnecting the AC power cord will not remove all dangerous voltages as the Defibrillator Module operates from battery as well as AC power.

CAUTION

Do not disconnect or remove any board assemblies in the Defibrillator Module unless the POWER is OFF. Some board assemblies contain devices that can be damaged if the board is removed when the power is on. Several components, including MOS devices, can be damaged by electrostatic discharge. Use conductive foam and grounding straps when servicing is required around sensitive components. Use care when unplugging IC's from high-grip sockets.

- Inspect printed circuit board surfaces for discoloration, cracks, breaks, and warping.
- Inspect printed circuit board conductors for breaks, cracks, cuts, erosion, or looseness.
- Inspect all assemblies for burnt or loose components.
- Inspect all chassis and panel mounted components for looseness, breakage, loose contacts or conductors.
- Inspect for disconnected, broken, cut, loose, or frayed cables or wires.

5-4. SYMPTOM INDEX

To begin troubleshooting, match the malfunction to an entry in the symptom index and perform the troubleshooting on the page referenced.

SYMPTOM INDEX

SYMPTOM	PAGE
Error Messages	5-3
System Dead	5-4
Defibrillator (HV Capacitor Charging) Problems	5-6
Display Problems	5-13
Battery Charging Problems	5-14
Low Voltage Supply Problems	5-15
Paddles ECG Amplifier Problems	5-16

ERROR MESSAGES

SYMPTOM	SUSPECT AREA	CHECKS
Display flashes "E2".	Defibrillator charging too slowly.	See Defibrillator Problems.
Display flashes "E3".	Defibrillator cap arcing.	See Defibrillator Problems.
Display flashes "E4".	Defibrillator charged but shouldn't be.	See Defibrillator Problems.
Display flashes "E5".	Defibrillator overcharged.	See Defibrillator Problems.
Display flashes "E6".	LV supply out of spec.	See Low Voltage Supply Problems.
Display flashes "E7".	A/D (A2A2 U102) won't respond.	See System Dead Problems.
Display flashes "E8".	Microcontroller A2A2U101 failed power up ROM test.	
Display flashes "EEE"	A1A1 Infrared Link.	Verify Monitor-Recorder module is turned on and properly connector.

SYSTEM DEAD

SYMPTOM	SUSPECT AREA	CHECKS
System dead.	Power.	Check battery voltage at A2A2P12. Check for +14.3 V at A2A2P13 when AC power cord is connected to AC source.
	A3A4 POWER ON Switch.	Check for continuity between A2A2J2 pin 2 and pin 7 (GND) when POWER ON key is pressed.
	A2A2K402.	Use a jumper wire to force ~+12v across coil, and verify relay operates (click). If A2A2K402 is closed instrument should be on.
	A2A2U402.	Verify A2A2U402 pin 1 is low impedance when pin 8 is greater than 2.5 V above pin 6.
	A2A2F401.	Check Fuse.
Instrument will only stay on while ON switch is held.	A2A2Q201.	+5V should hold A2A2Q201 on forcing the ON/OFF signal to ground.
V battery, +8V, +5 V –5 V correct, but instrument not on.	Clock Oscillator on A2A2.	Check A2A2U103 pins 7 and 8 for 12 MHz sine wave, with 5 V amplitude. Check A2A2U103 pin 9, and A2A2U101 pin 18 for 12 MHz square wave with 5 V amplitude.

SYSTEM DEAD — Continued

SYMPTOM	SUSPECT AREA	CHECKS
Same symptoms as above with or without a continuous power up. tone and display.	A2A2U101 or U103.	Check Vcc on A2A2U103 pins 18 and 68 for >4.5 V. Check A2A2U101 pin 40 for Vcc of 4.7 to 5.3 V. Check A2A2U102 pin 20 for Vcc of 4.9 to 5.1 V. Check A2A2U103 pin 2. This is the decoded "tickle" signal from A2A2U101. Signal should be a CMOS logic level signal with a period of 4.167ms (240Hz) and approximate 40% duty cycle. Check A2A2U101 pin 9 for a positive reset signal. Check for pins being stuck high, low, or disconnected on external address/data bus. A2A2U101 pins 32 thru 39; A2A2U103 pins 10, 12, 13, 14, 16, 17, 21, and 22; and A2A2U102 pins 9, 11 thru 17 should be active. Check WR signal between A2A2U101 (pin 16) and A2A2U103 (Pin 5). Normally high with narrow low going strobes. Check ALE signal between A2A2U101 (pin 30) and A2A2U103 (pin 4). Should be 2 MHz square wave with 300 ns high pulse. Check signal on A2A2C107 and A2A2U103 pin 3 during turn on. Should take several hundred milliseconds to charge to Vcc.

DEFIBRILLATOR PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Unit will not respond to Apex paddle charge button.	A3A1 Apex Paddle.	Verify continuity between A2A2J7 pins 1 and 5 when charge button is pressed.
	A2A2U105 or U101.	Verify A2A2U105 pin 2 is logic low when charge button is pressed, and logic high when released.
Unit will not respond to front panel Energy Select/Charge keys.	A2A2U205.	Verify logic low on appropriate A2A2U205 pin (3, 4, 11 - 14) when switch is pressed.
		Verify shift activity every 4 msec when U101 activates FP SER CLK (A2A2U205 pin 2).
Unit does not respond to discharge switches.	A3A2 Sternum Paddle.	Verify continuity between A2A2J8 pins 1 and 3 when discharge switch is pressed.
	A3A1 Apex Paddle.	Verify continuity between A2A2J7 pins 1 and 3 when discharge switch is pressed.
	A2A2U105.	Verify A2A2U105 pin 4 is a logic low when both discharge switches are pressed and a logic high otherwise.
	A2A2U106, U103, and U101.	Verify A2A2U106 pin 3 goes high when a discharge is requested and a logic low otherwise.
The defibrillator does not seem to charge. The displays indicates 0 joules, then in a few seconds displays "E2" and aborts charge.	A. The defibrillator is charging, but the capacitor voltage is not being recognized.	A. Listen for the high-pitched charging sound when charging is initiated. If it is heard, check A2A3TP4 and suspect A2A3U2D or a problem on the Vcap line to A2A2U102 (pin 2). Use caution in the high voltage area!

DEFIBRILLATOR PROBLEMS — Continued

SYMPTOM	SUSPECT AREA	CHECKS
	B. Cables A2A3P4, P18, P15; A2A3 power supplies; Fuse A2A3F1.	B. 1. Check cables A2A3P4, P18, P15 for proper connection and conduction. 2. Check the voltage at A2A3P4 pin 7 (SWBAT) with respect to A2A3TP1 (GND). It should be greater than 10 V. 3. Check the voltage at A2A3P4 pin 1 (V RAW) with respect to A2A3TP6 (GND, RAW). It should be greater than 10 V. 4. Check for fused V RAW voltage (on the right side of the fuse, looking at the component side of the board) with respect to A2A3TP6 (GND RAW). If it is less than V RAW, suspect A2A3F1. Remove the fuse and continue troubleshooting to find the cause of the failure.

DEFIBRILLATOR PROBLEMS — Continued

SYMPTOM	SUSPECT AREA	CHECKS
	C. A2A3U1 is not receiving the correct input or delivering the correct output.	C. With A2A3F1 removed, and during a charging attempt, ensure that: 1. A2A3U1 pin 10 is less than 700 mV. 2. A2A3U1 pin 7 has a sawtooth wave on it. 3. A2A3U1 pin 9 is above 1.5V. If not, and if CHG RATE CTRL is present, check A2A3TP2 and suspect A2A3U2C or U2B circuit. 4. A2A3U1 pin 1 voltage is less than pin 2 voltage. 5. A2A3U1 pin 4 voltage is less than 200 mV. 6. A2A3U1 pin 3 is not stuck high. If it is, check A2A3TP3 and suspect A2A3U2A or A2A3Q2. 7. A2A3TP7 is toggling from about zero to > 10 V.

DEFIBRILLATOR PROBLEMS — Continued

SYMPTOM	SUSPECT AREA	CHECKS
	D. Power MOSFET A2A3Q1 Transformer A2A3T1.	D. With A2A3F1 removed, ensure that: 1. The resistance from A2A3TP9 to A2A3TP7 is >1 MΩ with the positive ohmmeter lead on A2A3TP9. 2. The resistance from A2A3TP7 to A2A3TP8 is >400Ω with the positive ohmmeter lead on A2A3TP7. 3. The resistance from A2A3TP9 to A2A3TP8 is >1MΩ with the positive ohmmeter lead on A2A3TP9. 4. The resistance from A2A3TP8 to A2A3TP9 is like a diode with the positive ohmmeter lead on A2A3TP8. Then, with A2A3F1 in place, but when not attempting to charge; 1. Accurately measure the voltage from A2A3TP8 to A2A3TP6. If greater than 1mV, suspect A2A3Q1. 2. Measure the voltage at A2A3TP9. If less than V RAW, suspect A2A3T1 (primary). Then with A2A3F1 in place, and during a charging attempt, verify that A2A3TP7 is toggling from about zero to >10 V. 1. If A2A3TP9 is not toggling, suspect A2A3Q1. 2. If A2A3TP9 is toggling, suspect A2A3T1 (secondary).

DEFIBRILLATOR PROBLEMS — Continued

SYMPTOM	SUSPECT AREA	CHECKS
Slow charging (greater than 10 seconds to 360 joules with fully charged battery) or charge aborted with "E2" flashing on display.	A. A2A3P15 is disconnected.	A. Check A2A3P15 connection.
	B. A2A3K1 not opening.	B. With the instrument turned on and all cables connected, verify that "E4", "E5" or "E7" are not displayed on the front panel. Measure the voltage at A2A3TP4 and verify that it is less than 50mV. Turn the instrument off and short the 2 terminals of the HV Capacitor (A2C1) with an insulated-handle screwdriver; then connect an ohmmeter from A2A3C11 to A2A3R19 (neither connection at the junction of A2A3C11 and A2A3R19). Also connect a jumper from A2A3TP10 (A2A3CR1 anode) to A2A3TP1 (A2A3CR4 anode). Turn the instrument on. If the resistance indicates a short, suspect A2A3K1.
	C. A2A3CR9 or A2A3CR10 bad.	C. Disconnect A2A3P4, and measure the resistance across A2A3CR9. If a short is indicated, replace both A2A3CR9 and A2A3CR10.
	D. A2A3 Charge rate control circuit problem.	D. During an attempt to charge, measure the voltage at A2A3TP2. If it is less than 1.5V, suspect A2A3U2C.

DEFIBRILLATOR PROBLEMS — Continued

SYMPTOM	SUSPECT AREA	CHECKS
Charging begins, but then is aborted with "E3" flashing on the display.	A. HV Capacitor (A2C1) arc.	A. With the instrument turned on and all cables connected, verify that "E4", "E6", or "E7" are not displayed on the front panel. Measure the voltage at A2A3TP4 with respect to A2A3TP1 and verify that it is less than 50mV. Turn the instrument off and short the 2 terminals of the HV Capacitor (A2C1) with an insulated-handle screwdriver; then connect an ohmmeter across the 2 terminals. If the resistance settles to less than 30 kΩ , suspect A2C1. Remove the ohmmeter.
	B. A2A3 Capacitor voltage measurement problem.	B. Verify that A2C1 is not shorted (see section A directly above). Turn the instrument on and observe the voltage at A2A3U2 pin 12 during charge. After 800mV is reached, if there is >10% change in voltage within 10 ms, suspect transformer A2A3T1. Otherwise measure the voltage at A2A3TP4. After 800 mV is reached, if there is >10% change in voltage within 10 ms, suspect A2A3U2D.

DEFIBRILLATOR PROBLEMS — Continued

SYMPTOM	SUSPECT AREA	CHECKS
"E4" flashing on the display.	A. A2A3 Capacitor voltage measurement problem.	A. Measure the voltage at A2A3U2 pin 12. If it is greater than 50 mV, go to section B directly below. Otherwise measure the voltage at A2A3TP4. If it is <50 mV, suspect A2A3U2.
	B. A2A3 Safety circuit problem.	B. After performing step A directly above, turn the instrument off to ensure that there is no safety relay drive. Wait at least 20 seconds. Then turn the instrument on. If the "E4" indication does not reappear on the display within 10 seconds, perform the following steps: 1. Check the voltage at A2A3TP4 to verify that it is less than 50 mV. 2. Short the HV Capacitor (A2C1) with an insulated-handle screwdriver. 3. Remove A2A3F1 for further troubleshooting. 4. Suspect SAF RLY DRIVE signal at A2A3TP10.

DISPLAY PROBLEMS

SYMPTOM	**SUSPECT AREA**	**CHECKS**
Battery Charger LED not working.	Battery Charger off.	Verify instrument connected to AC source.
	BT1 Thermal Fuse.	Verify continuity between red and white wires (BT1P14 pins 1 and 3).
	Signal path.	Follow BATT CHG LED signal from A2A2 to A3A3.
	A2A2U401.	A2A2U401 pin 7 is logic low when charging battery.
Displays bright; frequent burnout.	+8.4V too high.	Check for +8.0 V to +8.8V from A2A2.
LED's (A3A3 DS1, DS2, DS3) not lighting or dim.	+8.4V too low.	Check for +8.0V to +8.8V from A2A2.
	A2A2U204.	Check for voltages across A2A2R215 while in SYNC mode.
LED's (A3A3 DS1, DS2, DS3) not lighting correctly.	A3A3DS1, DS2, or DS3	Check for drive signals to A2A2U204, and voltage across A2A2R214, 215, or 216.
One digit (A3A3DS4, DS5, DS6) not lighting correctly.	A3A3DS4, DS5, DS6, or A2A2U204.	Check for drive signals to A2A2U204. Interchange A3A3DS4, 5, 6 to determine if A2A2U204 or digit is bad.
One segment on one digit not lighting correctly.	A3A3DS4, DS5, DS6.	Interchange A3A3DS4, 5, 6 to verify bad digit.
Same segment on all digits not lighting correctly.	A2A2U202.	Check for drive signals to A2A2U202. Check for voltage across A2A2R206 thru R213.

BATTERY CHARGING PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
BT1 Battery not Charging or Instrument will not operate on AC only.	AC power.	Verify AC connected to appropriate power.
	A2A1 dead.	Verify 12 to 14.5 V at A2A2P13 when AC is connected.
	A2A2K401.	Verify A2A2K401 is closed when AC is connected, and open when AC disconnected (audible click).
	A2A2U401.	Verify A2A2U401 pin 1 is high when AC is connected.
	A2A2Q401.	Verify A2A2Q401 gate is high and transistor is conducting when AC is connected.
	BT1 Thermal Fuse.	Verify continuity between red and white wires (BT1P14 pins 1 and 3).

LOW VOLTAGE SUPPLY PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
+8V supply not operating correctly.	A2A2U405	12 to 14 V on A2A2U405 pin 3.
+8.4V supply not operating correctly.	A2A2U404	12 to 14 V on A2A2U404 pin 3.
+5V supply not operating correctly.	A2A2U406	Square wave switching occurring on A2A2U406 pin 2.
–5V supply not operating correctly.	A2A2+5V circuit	Verify adequate load on +5V to allow charge pump to store charge on A2A2C421.

PADDLES ECG AMPLIFIER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
50/60 Hz noise on ECG trace.	Electromagnetically noisy environment.	Check grounding of nearby equipment.
	High electrode impedance.	Use Redux® (P/N 651-1008-50) paste, abraid skin, press with 25 lbs of force.
	Imbalance in paddles input impedance.	Compare resistance of A2A2R301-R306 ±5%.
	Use leads.	
ECG noise, not 50/60 Hz.	A2A2 Isolated circuits.	Short across A2A2T301 pins 1 and 2 and observe.
		Short across A2A2C302 and observe.
		Short across A2A2C301 and observe.
	A2A2 Grounded circuits.	Short A2A2U306 pin 1 to ground and observe.
		Short junction of A2A2R332 and R333 to ground and observe.
		Short A2A2U304 pin 3 to ground and observe.
Paddles Amp does not meet 0.5Hz bandwidth spec.	A2A2C306, R325, R326.	Verify component values.
Paddles ECG Offset from center of displays.	A2A2R328.	Adjust ECG Offset (Section III, paragraph 3-13).
	A2A2U304.	Check Offset voltage and or high input bias currents on A2A2U304 pin 3.
ECG Gain Incorrect.	A2A2R331.	Adjust ECG gain (section III, paragraph 3-12).
	A2A2U305.	Measure ON resistance for each of eight multiplexer channels.

6-1. INTRODUCTION

This section of the service manual includes schematic diagrams and identifies major assemblies, subassemblies, and components of the 43130M Defibrillator module to aid in ordering replacement parts and troubleshooting. Each entry in the material list tables includes the reference designation, HP part number, quantity used within the referenced assembly, a brief description of the part and the part number assigned by the manufacturer. Wherever possible, parts lists for the assemblies are printed on the same page as the schematic diagram and component location drawing or on immediate adjacent pages.

6-2. REFERENCE DESIGNATIONS

The parts listings use an alphabetical-numerical (alpha-numeric) method of listing the end item, assemblies, subassemblies and circuit components. These items are defined as follows:

1. An END ITEM is the instrument with all the supplied accessories. The END ITEM is made up of assemblies to aid in the location of parts.
2. Each assembly and subassembly is assigned an "A" number (A1, A2, A3, etc). Assemblies and subassemblies that can be purchased have part numbers in the part number column of the table; those that cannot be purchased do not have part numbers in the columns.
3. Components within the assembly and subassembly circuits are assigned circuit reference designators (C1 capacitor, R1 resistor, etc). These parts are prefaced by the assembly number (A1C1, A2C2, A1R1, A2R2, etc), to indicate the assembly on which the part is located.

An example of the alpha-numeric numbering method used to identify assemblies, subassemblies and circuit components is shown below:

A1 R 1

Assembly No.

Component Alpha Designation

Component Numeric Designation

6-3. FIGURE AND INDEX NUMBERS

Mechanical parts on some assemblies may be identified by an index number. These items are defined as follows:

1. Each assembly and subassembly is assigned an "6-" figure number (6-1, 6-2, etc).
2. Components within the assembly and subassembly circuits are assigned an index number (1, 2, 3, etc). These parts are prefaced by the assembly figure number (6-3-1, 6-4-12, etc), to indicate the assembly on which the part is located.

An example of the figure and index numbering method used to identify mechanical components is shown below:

6-1 -12

Assembly Fig. No.

Component Index Number

The complete figure and index number is read as the 6-1-12.

6-4. ORDERING INFORMATION

NOTE

Occasionally, electronic items in the replacement parts list will be found to carry standard commercial identification numbers but which also are indicated as being manufactured by HP. These components have been selected to meet specific operational criteria. The use of these components purchased through normal commercial channels may result in degradation of the operation performance or reliability of the unit.

To order a replacement part, address order or inquiry to the local Hewlett-Packard Sales/Service office (see list of addresses at the rear of the this manual) and supply the HP part number of the item from the listing.

To order a part not listed in a table, provide the following information:

1. Model number of the instrument.
2. Complete serial number of the instrument.
3. Description of the part including function and location.

To order a part from a manufacturer other than Hewlett-Packard Company, provide the complete part description and the manufacturer's part number from the listing. Manufacturer's codes are listed in Table 6-1.

Table 6-1. Manufacturer's Code

MFR NO.	MANUFACTURER NAME	ADDRESS		ZIP CODE
0003J	NIPPON ELECTRIC CO			
00853	SANGAMO ELEC CO S CAROLINA DIV	PICKENS	SC	29671
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01281	TRW INC SEMICONDUCTOR DIV	LAWNDALE	CA	90260
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
0192B	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	08876
02111	SPECTROL ELECTRONICS CORP	CITY OF IND	CA	91745
03508	GE CO SEMICONDUCTOR PROD DEPT	SYRACUSE	NY	13201
03888	KDI PYROFILM CORP	WHIPPANY	NJ	07981
04222	AVX CERAMICS CORP	MYRTLE BEACH	SC	29577
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85062
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
12617	HAMLIN INC	LAKE MILLS	WI	53551
13606	SPRAGUE ELECT CO SEMICOND DIV	CONCORD	NH	03301
17856	SILICONIX INC	SANTA CLARA	CA	95054
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
20932	EMCON DIV ITW	SAN DIEGO	CA	92129
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
25088	SIEMENS CORP	ISELIN	NJ	08830
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	95051
27777	VARO SEMICONDUCTOR INC	GARLAND	TX	75040
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
32293	INTERSIL INC	CUPERTINO	CA	95014
34649	INTEL CORP	MOUNTAIN VIEW	CA	95051
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
71590	CENTRALAB ELEK DIV GLOBE-UNION INC	MILWAUKEE	WI	50501
72136	ELECTRO MOTIVE CORP SUB INC	WILLIMANTIC	CT	06226
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA	PA	19108
75915	LITTELFUSE INC	DES PLAINES	IL	60016
84411	TRW CAPACITOR DIV	OGALLALA	NE	69153

Table 6-2. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

A	assembly
AT	attenuator; isolator; termination
B	fan; motor
BT	battery
C	capacitor
CP	coupler
CR	diode; diode thyristor; varactor
DC	directional coupler
DL	delay line
DS	annunciator; signaling device (audible or visual); lamp; LED
E	miscellaneous electrical part
F	fuse
FL	filter
H	hardware
HY	circulator
J	electrical connector (stationary portion); jack
K	relay
L	coil; inductor
M	meter
MP	miscellaneous mechanical part
P	electrical connector (movable portion); plug
Q	transistor: SCR; triode thyristor
R	resistor
RT	thermistor
S	switch
T	transformer
TB	terminal board
TC	thermocouple
TP	test point
U	integrated circuit; microcircuit
V	electron tube
VR	voltage regulator; breakdown diode
W	cable; transmission path; wire
X	socket
Y	crystal unit (piezo-electric or quartz)
Z	tuned cavity; tuned circuit

ABBREVIATIONS

A	ampere
ac	alternating current
ACCESS	accessory
ADJ	adjustment
A/D	analog-to-digital
AF	audio frequency
AFC	automatic frequency control
AGC	automatic gain control
AL	aluminum
ALC	automatic level control
AM	amplitude modulation
AMPL	amplifier
APC	automatic phase control
ASSY	assembly
AUX	auxiliary
avg	average
AWG	American wire gauge
BAL	balance
BCD	binary coded decimal
BD	board
BE CU	beryllium copper
BFO	beat frequency oscillator
BH	binder head
BKDN	breakdown
BP	bandpass
BPF	bandpass filter
BRS	brass
BWO	backward-wave oscillator
CAL	calibrate
ccw	counter-clockwise
CER	ceramic
CHAN	channel
cm	centimeter
CMO	cabinet mount only
COAX	coaxial
COEF	coefficient
COM	common
COMP	composition
COMPL	complete
CONN	connector
CP	cadmium plate
CRT	cathode-ray tube
CTL	complementary transistor logic
CW	continuous wave
cw	clockwise
cm	centimeter
D/A	digital-to-analog
dB	decibel
dBm	decibel referred to 1 mW
dc	direct current
deg	degree (temperature interval or difference)
...°	degree (plane angle)
°C	degree Celsius (centigrade)
°F	degree Fahrenheit
°K	degree Kelvin
DEPC	deposited carbon
DET	detector
diam	diameter
DIA	diameter (used in parts list)
DIFF AMPL	differential amplifier
div	division
DPDT	double-pole, double-throw
DR	drive
DSB	double sideband
DTL	diode transistor logic
DVM	digital voltmeter
ECL	emitter coupled logic
EMF	electromotive force
EDP	electronic data processing
ELECT	electrolytic
ENCAP	encapsulated
EXT	external
F	farad
FET	field-effect transistor
F/F	flip-flop
FH	flat head
FIL H	fillister head
FM	frequency modulation
FP	front panel
FREQ	frequency
FXD	fixed
g	gram
GE	germanium
GHz	gigahertz
GL	glass
GRD	ground(ed)
H	henry
h	hour
HET	heterodyne
HEX	hexagonal
HD	head
HDW	hardware
HF	high frequency
HG	mercury
HI	high
HP	Hewlett-Packard
HPF	high pass filter
HR	hour (used in parts list)
HV	high voltage
Hz	Hertz
IC	integrated circuit
ID	inside diameter
IF	intermediate frequency
IMPG	impregnated
in	inch
INCD	incandescent
INCL	include(s)
INP	input
INS	insulation
INT	internal
kg	kilogram
kHz	kilohertz
kΩ	kilohm
kV	kilovolt
lb	pound
LC	inductance-capacitance
LED	light-emitting diode
LF	low frequency
LG	long
LH	left hand
LIM	limit
LIN	linear taper (used in parts list)
lin	linear
LK WASH	lock washer
LO	low; local oscillator
LOG	logarithmic taper (used in parts list)
log	logrithm(ic)
LPF	low pass filter
LV	low voltage
m	meter (distance)
mA	milliampere
MAX	maximum
MΩ	megohm
MEG	meg (10^6) (used in parts list)
MET FLM	metal film
MET OX	metallic oxide
MF	medium frequency; microfarad (used in parts list)
MFR	manufacturer
mg	milligram
MHz	megahertz
mH	millihenry
mho	mho
MIN	minimum
min	minute (time)
...'	minute (plane angle)
MINAT	miniature
mm	millimeter

NOTE

All abbreviations in the parts list will be in upper-case.

Table 6-2. Reference Designations and Abbreviations (cont'd)

MOD	modulator
MOM	momentary
MOS	metal-oxide semiconductor
ms	millisecond
MTG	mounting
MTR	meter (indicating device)
mV	millivolt
mVac	millivolt, ac
mVdc	millivolt, dc
mVpk	millivolt, peak
mVp-p	millivolt, peak-to-peak
mVrms	millivolt, rms
mW	milliwatt
MUX	multiplex
MY	mylar
µA	microampere
µF	microfarad
µH	microhenry
µmho	micromho
µs	microsecond
µV	microvolt
µVac	microvolt, ac
µVdc	microvolt, dc
µVpk	microvolt, peak
µVp-p	microvolt, peak-to-peak
µVrms	microvolt, rms
µW	microwatt
nA	nanoampere
NC	no connection
N/C	normally closed
NE	neon
NEG	negative
nF	nanofarad
NI PL	nickel plate
N/O	normally open
NOM	nominal
NORM	normal
NPN	negative-positive-negative
NPO	negative-positive zero (zero temperature coefficient)
NRFR	not recommended for field replacement
NSR	not separately replaceable
ns	nanosecond
nW	nanowatt
OBD	order by description
OD	outside diameter
OH	oval head
OP AMPL	operational amplifier
OPT	option
OSC	oscillator
OX	oxide
oz	ounce
Ω	ohm
P	peak (used in parts list)
PAM	pulse-amplitude modulation
PC	printed circuit
PCM	pulse-code modulation; pulse-count modulation
PDM	pulse-duration modulation
pF	picofarad
PH BRZ	phosphor bronze
PHL	Phillips
PIN	positive-intrinsic-negative
PIV	peak inverse voltage
pk	peak
PL	phase lock
PLO	phase lock oscillator
PM	phase modulation
PNP	positive-negative-positive
P/O	part of
POLY	polystyrene
PORC	porcelain
POS	positive; position(s) (used in parts list)
POSN	position
POT	potentiometer
p-p	peak-to-peak
PP	peak-to-peak (used in parts list)
PPM	pulse-position modulation
PREAMPL	preamplifier
PRF	pulse-repetition frequency
PRR	pulse repetition rate
ps	picosecond
PT	point
PTM	pulse-time modulation
PWM	pulse-width modulation
PWV	peak working voltage
RC	resistance-capacitance
RECT	rectifier
REF	reference
REG	regulated
REPL	replaceable
RF	radio frequency
RFI	radio frequency interference
RH	round head; right hand
RLC	resistance-inductance-capacitance
RMO	rack mount only
rms	root-mean-square
RND	round
ROM	read-only memory
R&P	rack and panel
RWV	reverse working voltage
S	scattering parameter
s	second (time)
"	second (plane angle)
S-B	slow-blow (fuse) (used in parts list)
SCR	silicon controlled rectifier; screw
SE	selenium
SECT	sections
SEMICON	semiconductor
SHF	superhigh frequency
SI	silicon
SIL	silver
SL	slide
SNR	signal-to-noise ratio
SPDT	single-pole, double-throw
SPG	spring
SR	split ring
SPST	single-pole, single-throw
SSB	single sideband
SST	stainless steel
STL	steel
SQ	square
SWR	standing-wave ratio
SYNC	synchronize
T	timed (slow-blow fuse)
TA	tantalum
TC	temperature compensating
TD	time delay
TERM	terminal
TFT	thin-film transistor
TGL	toggle
THD	thread
THRU	through
TI	titanium
TOL	tolerance
TRIM	trimmer
TSTR	transistor
TTL	transistor-transistor logic
TV	television
TVI	television interference
TWT	traveling wave tube
U	micro (10^{-6}) (used in parts list)
UF	microfarad (used in parts list)
UHF	ultrahigh frequency
UNREG	unregulated
V	volt
VA	voltampere
Vac	volts, ac
VAR	variable
VCO	voltage-controlled oscillator
Vdc	volts, dc
VDCW	volts, dc, working (used in parts list)
V(F)	volts, filtered
VFO	variable-frequency oscillator
VHF	very-high frequency
Vpk	volts, peak
Vp-p	volts, peak-to-peak
Vrms	volts, rms
VSWR	voltage standing wave ratio
VTO	voltage-tuned oscillator
VTVM	vacuum-tube voltmeter
V(X)	volts, switched
W	watt
W/	with
WIV	working inverse voltage
WW	wirewound
W/O	without
YIG	yttrium-iron-garnet
Z_o	characteristic impedance

NOTE

All abbreviations in the parts list will be in upper-case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
µ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

43130M Defibrillator
See Figure 6-1 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43131-67302	1	ENCL ASSY - DEFIB
A2	43131-67101	1	CHAS ASSY - DEFIB
A3	43131-67201	1	FR PNL ASSY - DEFIB
BT1	43131-67202	1	BATTERY ASSY
6-1-1	1400-1526	2	TWIST LOCK TIE
6-1-2	2190-0142	6	WSHR FLAT 6 x .5
6-1-3	2360-0121	18	PHMS-6-32X.5 P
6-1-4	2420-0006	9	NUT-HX LK WSHR
6-1-5	3050-1325	18	WSHR - SEAL 8
6-1-6	43131-07308	1	COVER-BATTERY
6-1-7	Deleted		
6-1-8	651-1008-050	1	REDUX
	43131-84501	1	NAMEPLATE-S/N
	43131-84504	1	LABEL-NO BATT

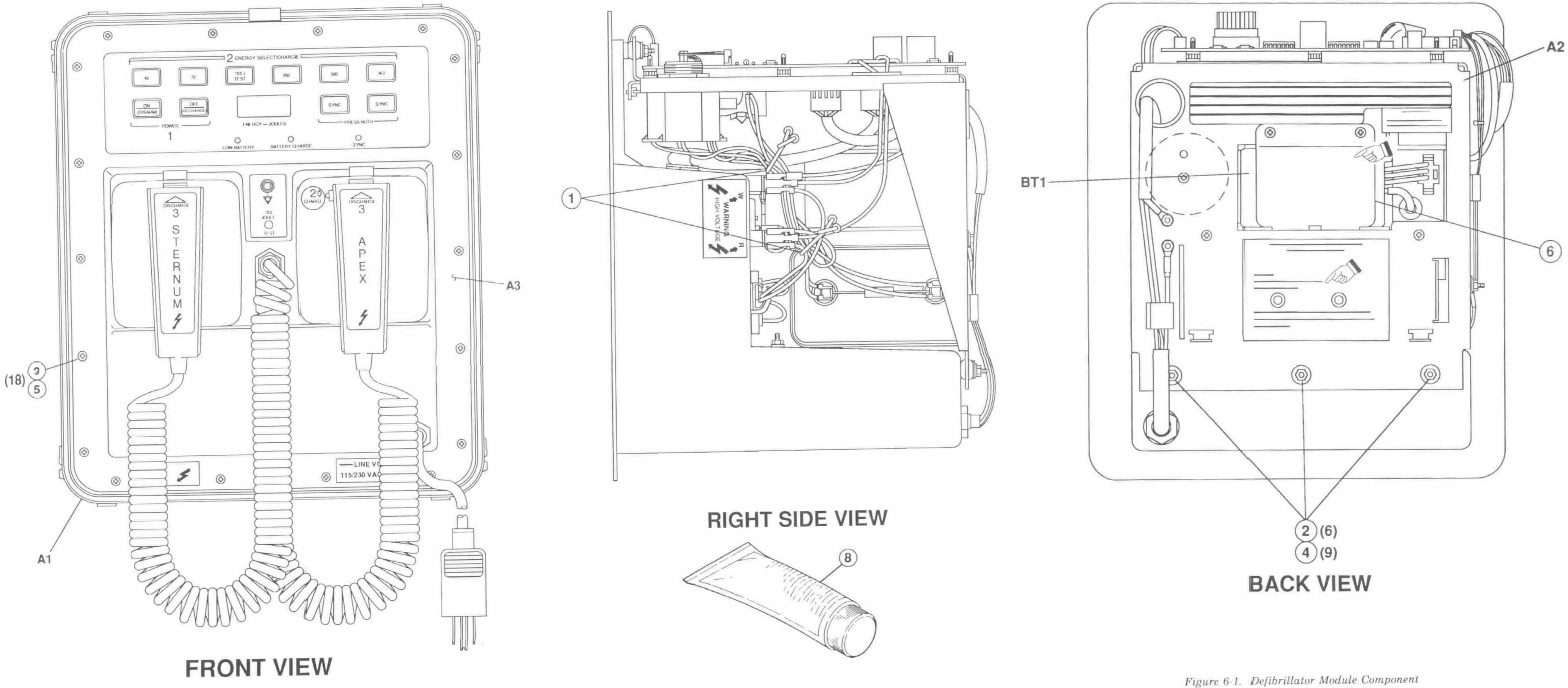

2 ENERGY SELECT/CHARGE
ON DISARM
OFF DISCHARGE
POWER
1
ENERGY — JOULES
SYNC
SYNC
PRESS BOTH
LOW BATTERY
BATTERY CHARGE
SYNC
DISCHARGE
3
STERNUM
APEX
2
CHARGE
TEST
LINE V
115/230 VA
A1
A3
(18) 3
5
1
WARNING HIGH VOLTAGE
8
BT1
A2
6
2 (6)
4 (9)
FRONT VIEW
RIGHT SIDE VIEW
BACK VIEW

Figure 6-1. Defibrillator Module Component Locator and Functional Block /Wiring Diagram (Sheet 1 of 2).

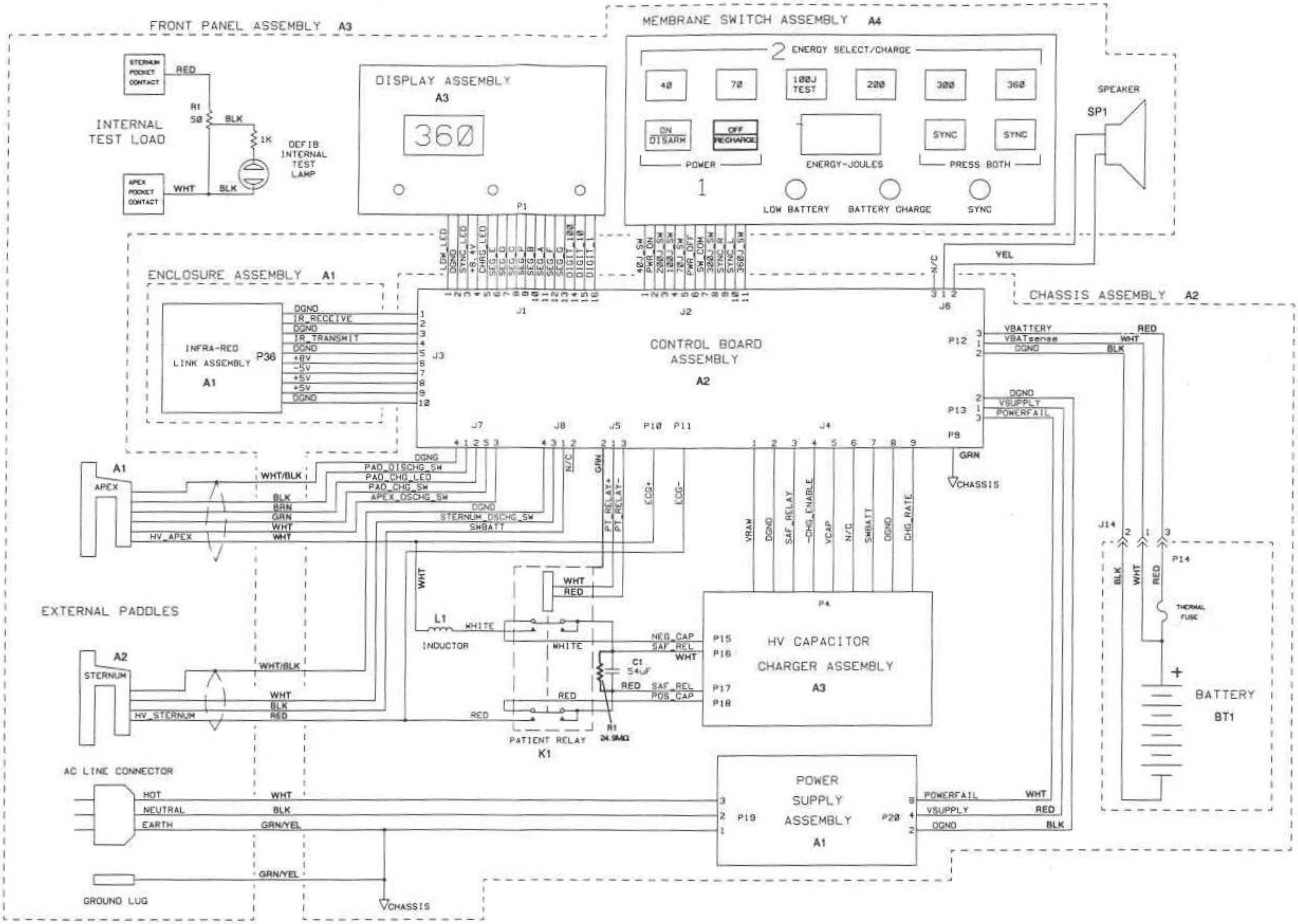

FRONT PANEL ASSEMBLY A3
STERNUM POCKET CONTACT
APEX POCKET CONTACT
RED
WHT
BLK
R1 50
1K
INTERNAL TEST LOAD
DEFIB INTERNAL TEST LAMP
DISPLAY ASSEMBLY A3
360
P1
LOW_LED
DGND
SYNC_LED
+8.4V
CHRG_LED
SEG_E
SEG_D
SEG_C
SEG_B
SEG_A
SEG_F
SEG_G
DIGIT_100
DIGIT_10
DIGIT_1
MEMBRANE SWITCH ASSEMBLY A4
2 ENERGY SELECT/CHARGE
40
70
100J TEST
200
300
360
ON DISARM
OFF RECHARGE
SYNC
POWER
ENERGY-JOULES
PRESS BOTH
1
LOW BATTERY
BATTERY CHARGE
SYNC
40J_SW
PWR_ON
200J_SW
100J_SW
70J_SW
PWR_OFF
SW_COM
300J_SW
SYNC_R
SYNC_L
360J_SW
SPEAKER
SP1
YEL
N/C
ENCLOSURE ASSEMBLY A1
INFRA-RED LINK ASSEMBLY A1
P36
DGND
IR_RECEIVE
IR_TRANSMIT
+8V
-5V
+5V
J3
J1
J2
J6
CONTROL BOARD ASSEMBLY A2
CHASSIS ASSEMBLY A2
P12
VBATTERY
VBATsense
P13
VSUPPLY
POWERFAIL
P9
GRN
CHASSIS
J7
J8
J5
P10
P11
J4
DGNG
PAD_DISCHG_SW
PAD_CHG_LED
PAD_CHG_SW
APEX_DSCHG_SW
STERNUM_DSCHG_SW
SWBATT
PT_RELAY+
PT_RELAY-
ECG+
ECG-
VRAM
SAF_RELAY
-CHG_ENABLE
VCAP
CHG_RATE
A1
APEX
WHT/BLK
BLK
BRN
GRN
WHT
HV_APEX
EXTERNAL PADDLES
A2
STERNUM
HV_STERNUM
L1
INDUCTOR
WHITE
PATIENT RELAY
K1
C1 54uF
R1 24.9MΩ
NEG_CAP
SAF_REL
POS_CAP
P4
P15
P16
P17
P18
HV CAPACITOR CHARGER ASSEMBLY A3
J14
P14
THERMAL FUSE
BATTERY BT1
+
AC LINE CONNECTOR
HOT
NEUTRAL
EARTH
GRN/YEL
GROUND LUG
POWER SUPPLY ASSEMBLY A1
P19
P20

Figure 6-1. Defibrillator Module Component Locator and Functional Block /Wiring Diagram (Sheet 2 of 2).

43131-67302 A1 Defibrillator Enclosure Assembly
See Figure 6-2 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43201-66540	1	PC ASSY-OPTICAL
6-2-1	2360-0113	2	PHMS-6-32X.25 P
6-2-2	43131-67303	1	CASE ASSY
	43131-84502	1	LABEL-OUTER CASE

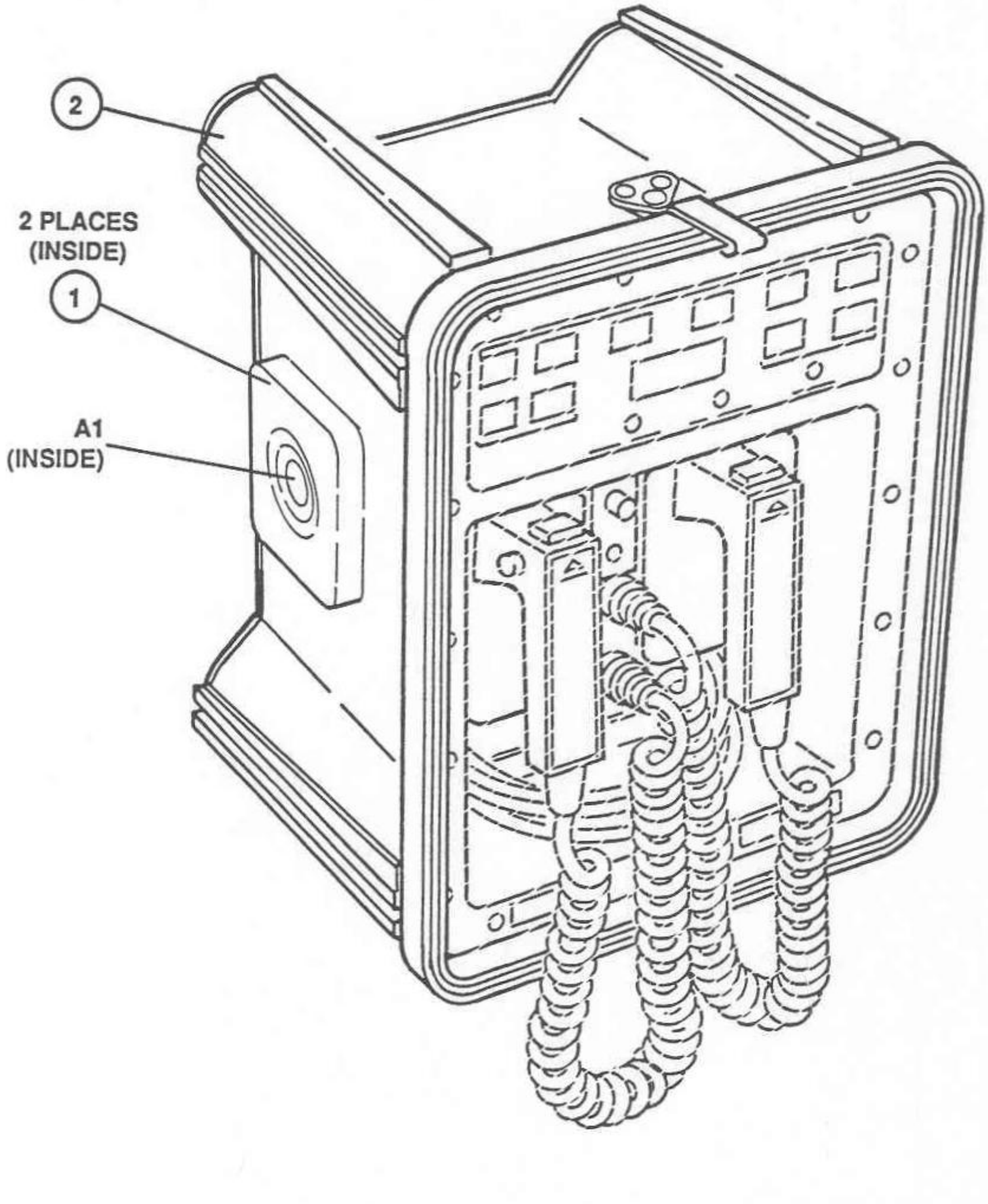
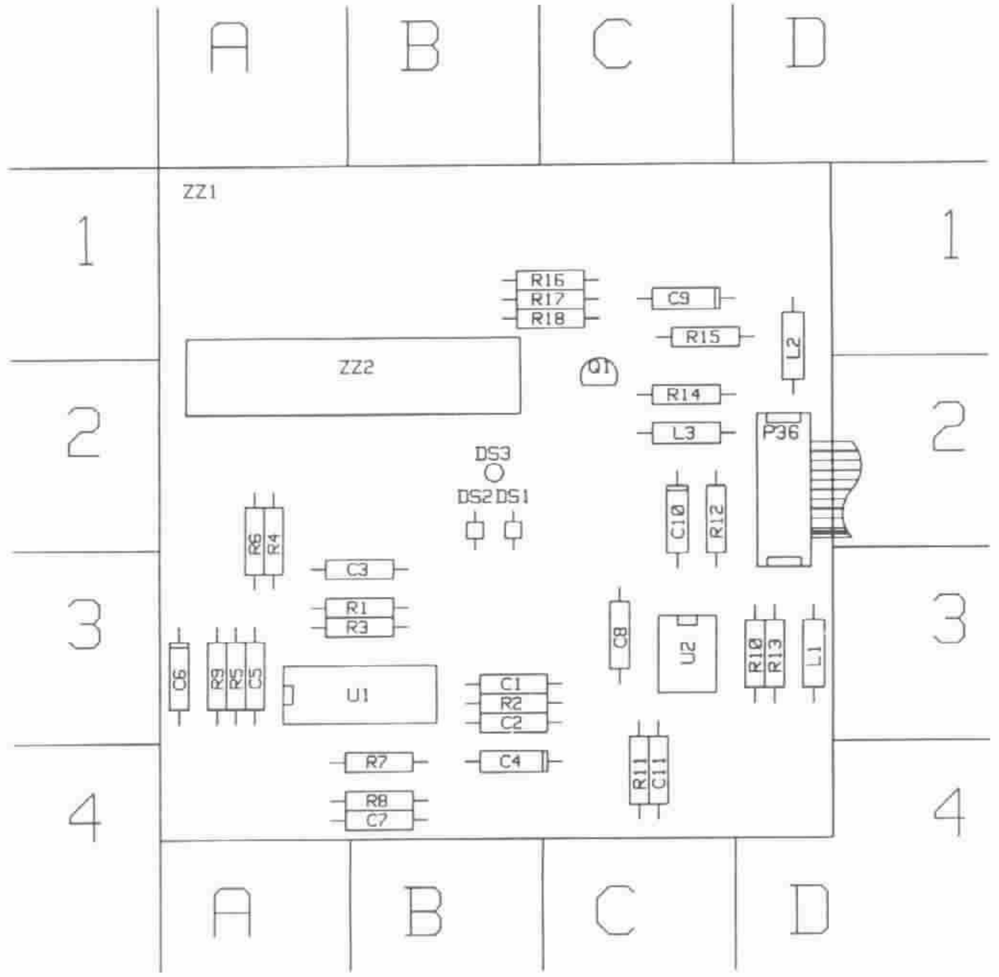


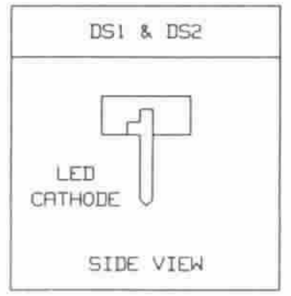
Figure 6-2. A1 Enclosure Assembly Component Locator.

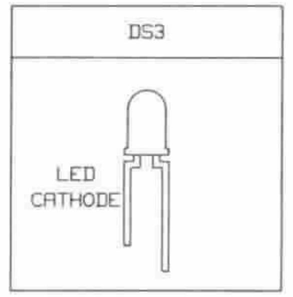
43201-66540 A1A1 Infrared Link Circuit Card Assembly
See Figure 6-3 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
C1,3,7,8,11	0160-4832	5	CAP .01UF 10%
C2,5	0160-4801	2	CAP 100PF 5%
C4,9,10	0180-3551	3	CAP-FIXED 6.8UF
C6	0180-3622	1	CAP-FIXED-ELEC
DS1,2	1990-1291	2	PIN-PHOTODIODE
DS3	1990-1292	1	LED-IR
L1-3	9100-2265	3	INDCTR 10UH 10%
P36	43201-61615	1	CBL ASSY
Q1	1855-0696	1	TRANSISTOR
R1	0757-0447	1	RES-16.2K 1% .12
R2,6,7,10-12	0698-3155	6	RES-4.64K 1% .12
R3,4,8,15	0698-0084	4	RES-2.15K 1% .12
R5,9,13,14,16-18	0698-3438	7	RES 147 1% .125W
U1	1858-0040	1	XSTR ARY 16P-DIP
U2	1826-0412	1	IC 393
ZZ1	43201-86540	1	PC BD-OPTICAL
ZZ2	43201-84704	1	LABEL-BAR CODE

REF DESIG	GRID LOC	PART NUMBER
C1	B3	0160-4832
C10	C2	0180-3551
C11	C4	0160-4832
C2	B3	0160-4801
C3	A3	0160-4832
C4	B4	0180-3551
C5	A3	0160-4801
C6	A3	0180-3622
C7	B4	0160-4832
C8	C3	0160-4832
C9	C1	0180-3551
DS1	B2	1990-1291
DS2	B2	1990-1291
DS3	B2	1990-1292
L1	D3	9100-2265
L2	D2	9100-2265
L3	C2	9100-2265
P36	D2	43201-61615
Q1	C2	1855-0696
R1	A3	0757-0447
R10	D3	0698-3155
R11	C4	0698-3155
R12	C2	0698-3155
R13	D3	0698-3438
R14	C2	0698-3438
R15	C1	0698-0084
R16	B1	0698-3438
R17	B1	0698-3438
R18	B1	0698-3438
R2	B3	0698-3155
R3	A3	0698-0084
R4	A3	0698-0084
R5	A3	0698-3438
R6	A3	0698-3155
R7	B4	0698-3155
R8	B4	0698-0084
R9	A3	0698-3438
U1	A3	1858-0040
U2	C3	1826-0412
ZZ1	A1	43201-86540
ZZ2	A2	43201-84704


A
B
C
D
1
2
3
4
ZZ1
ZZ2
R16
R17
R18
C9
R15
L2
Q1
R14
L3
P36
DS3
DS2 DS1
R6
R4
C10
R12
C3
R1
R3
C8
U2
R10
R13
L1
C6
R9
R5
C5
U1
C1
R2
C2
R7
C4
R11
C11
R8
C7


DS1 & DS2
LED
CATHODE
SIDE VIEW


DS3
LED
CATHODE

PCB	43201-86540	ZZ1
BAR CODE LABEL	43201-84704	ZZ2

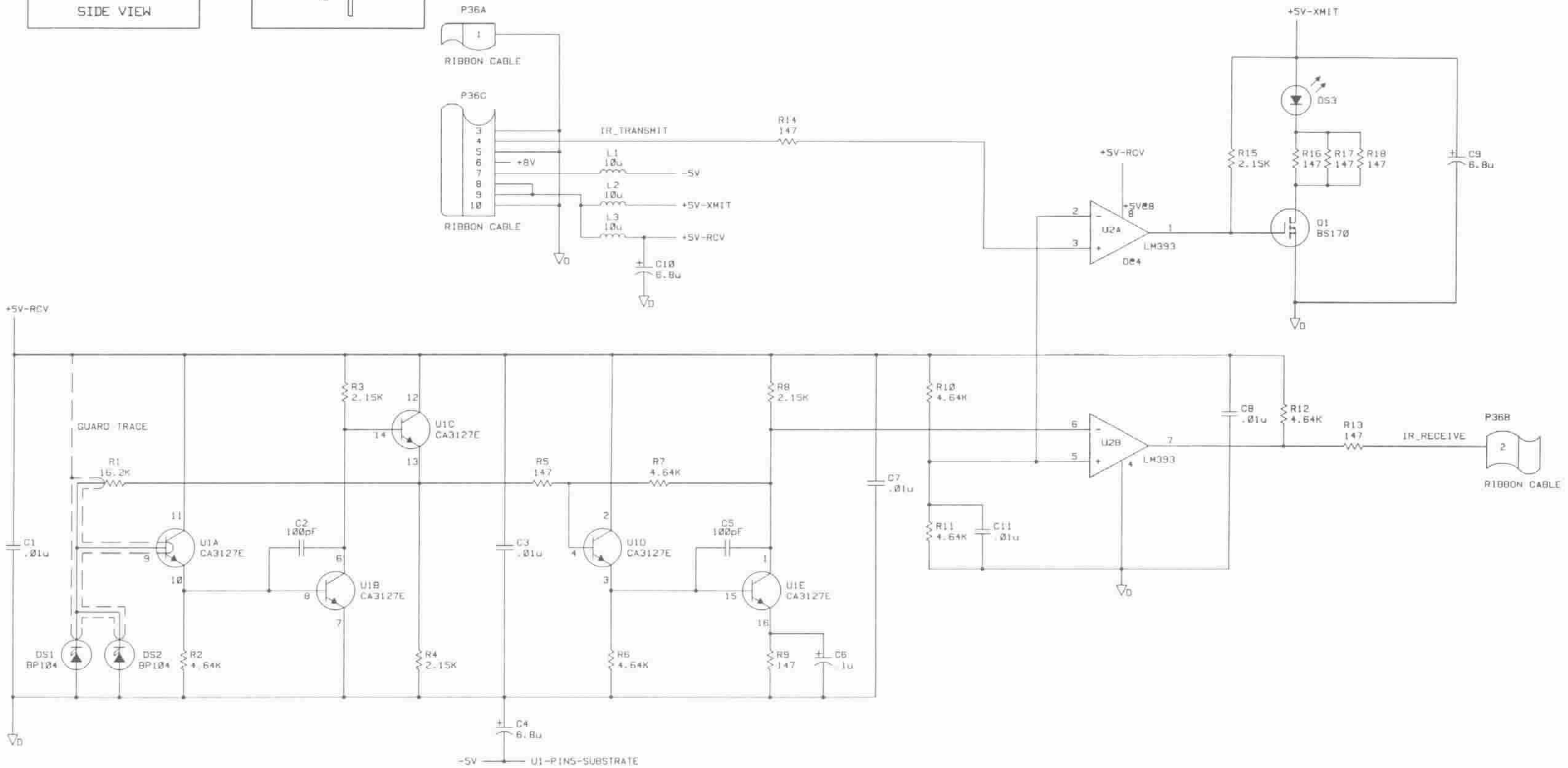
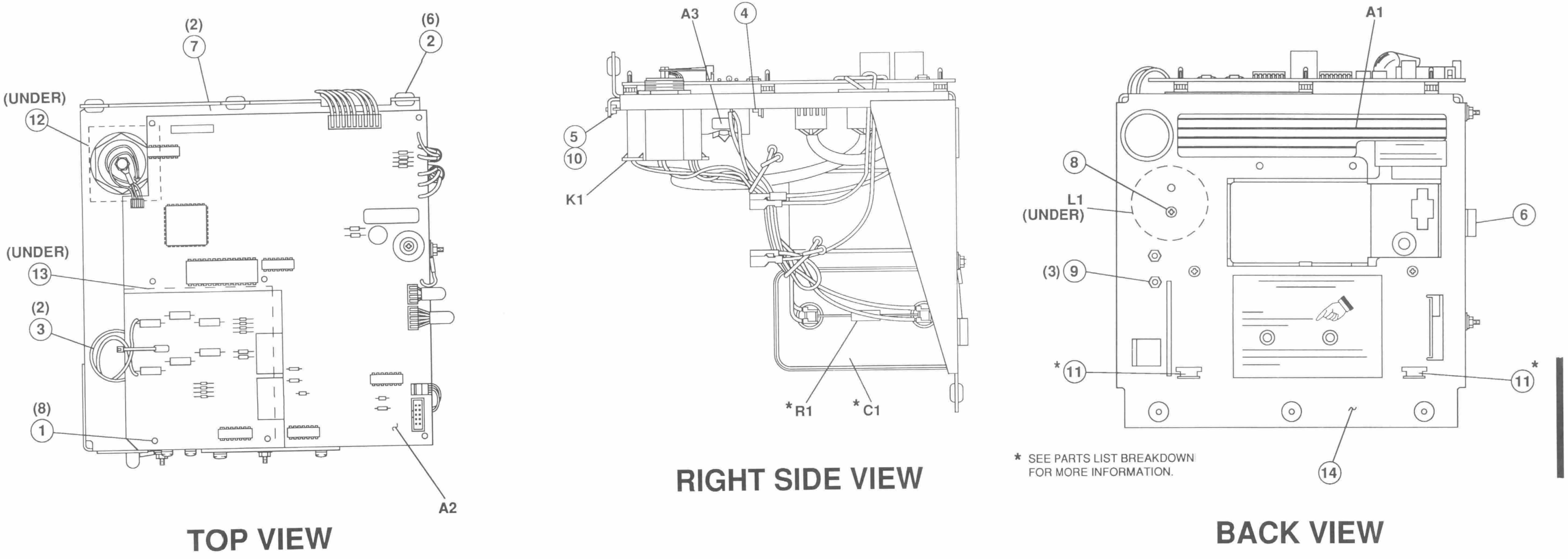

P36A
1
RIBBON CABLE
P36C
3
4
5
6
7
8
9
10
RIBBON CABLE
+8V
IR_TRANSMIT
R14
147
L1
10u
-5V
L2
10u
+5V-XMIT
L3
10u
+5V-RCV
C10
6.8u
+5V-RCV
+5V@8
8
2
3
U2A
LM393
1
D@4
+5V-XMIT
DS3
R15
2.15K
R16
147
R17
147
R18
147
C9
6.8u
Q1
BS170
+5V-RCV
GUARD TRACE
R1
16.2K
C1
.01u
11
9
10
U1A
CA3127E
DS1
BP104
DS2
BP104
R2
4.64K
C2
100pF
6
8
7
U1B
CA3127E
R3
2.15K
12
14
13
U1C
CA3127E
R4
2.15K
R5
147
C3
.01u
C4
6.8u
-5V
U1-PINS-SUBSTRATE
R7
4.64K
2
4
3
U1D
CA3127E
R6
4.64K
C5
100pF
1
15
16
U1E
CA3127E
R8
2.15K
R9
147
C6
1u
C7
.01u
R10
4.64K
R11
4.64K
C11
.01u
6
5
U2B
LM393
7
4
C8
.01u
R12
4.64K
R13
147
IR_RECEIVE
P36B
2
RIBBON CABLE

Figure 6-3. A1A1 Infrared Link Circuit Card Assembly Component Locator and Schematic Diagram.

43131-67201 A3 Front Panel Assembly
See Figure 6-7 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43131-60400	1	PDL SET-APEX
A2	43131-60401	1	PDL SET-STERNUM
A3	43131-66570	1	PC AY-CONT DISP
A4	43131-67200	1	SW PNL-MEMBRANE
J1	1510-0038	1	BINDING POST-SGL
LP1	1450-0651	1	NEON LAMP
P6	43131-61606	1	CBL AY-SPEAKER
P19	43131-61602	1	CBL AY-AC PWR
P25	43131-61603	1	CBL AY-PS AC
P26	43131-61604	1	CBL AY-PDL CONT
P27	43131-61605	1	CBL AY-PDL CONT
P28	43131-61607	1	CBL AY-GND TERM
R1	0811-3832	1	RES-TPD
SP1	9160-0292	1	SPEAKER
6-7-1	0360-2233	2	TERMINAL
6-7-2	1400-1549	5	CABLE CLAMP
6-7-3	2360-0113	7	PHMS-6-32X.25 P
6-7-4	2510-0168	2	BHMS 8-32X.38
6-7-5	2580-0017	2	NUT-W/LKWSR 8-32
6-7-6	2950-0071	1	NUT-HEX 1/4-32
6-7-7	3050-0938	2	WSHR-FLAT 8
6-7-8	43131-07309	2	PADDLE CONTACT
6-7-9	43131-07310	2	RESISTOR MOUNT
6-7-10	43131-27301	1	ACORN NUT 1/4-32
6-7-11	43131-46701	2	PADDLE CON SEAL
6-7-12	43131-47205	1	PANEL-FRONT
6-7-13	43131-47300	2	PADDLE RETAINER
6-7-14	43131-84500	1	LBL SET-FRNT PNL
6-7-15	78620-00849	1	WASHER
6-7-16	43131-84505	1	LABEL, INFORMATION
	0890-0561	3	TBG-HS .187-DIA
	0890-1274	1	TUBING-FLEX
	1400-0307	1	TIE WRAP


(2)
7
(6)
2
(UNDER)
12
(UNDER)
13
(2)
3
(8)
1
A2
TOP VIEW
A3
4
5
10
K1
*R1
*C1
RIGHT SIDE VIEW
A1
8
L1
(UNDER)
6
(3) 9
*11
11*
14
BACK VIEW

* SEE PARTS LIST BREAKDOWN FOR MORE INFORMATION.

Figure 6-4. A2 Chassis Assembly Component Locator.

43131-66560 A2A2 Control Circuit Card Assembly
See Figure 6-5 for Parts Breakdown

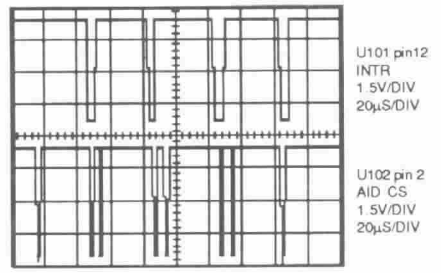
Reference Designator	Part Number	Qty	Description
C101,111,302,309,310, C409-411,415,418,424,425, C426,429,430,433,434	0160-5422	17	CAP .047UF 20%
C102,106	0180-3626	2	C-F .68UF 25V TA
C103,104,401	0160-4832	3	CAP .01UF 10%
C105	0160-4830	1	CAP 2200PF 10%
C107,110,403,408,413,422	0180-3552	6	CAP-FIXED 4.7UF
C108,109	0160-3875	2	CAP 22PF 5% 200V
C112,303,304,311,435	0180-3551	5	CAP-FIXED 6.8UF
C201	0160-3335	1	CAP 470PF 10%
C301,307,308,405	0160-4574	4	CAP 1000PF 10%
C305,402,404	0160-6623	3	.1UF 20% 50V
C306	0160-4441	1	CAP .47UF 10%
C406,423,428	0180-3422	3	C-F 10UF 10V TA
C407,416,421	0180-3553	3	CAP-FIXED 3.3UF
C420	0160-4846	1	CAP 1500PF 5%
C427	0180-4127	1	CAPACITOR-ALUM
CR101,103-111,121,122, CR203,204,301-309,311, CR313-320	1901-0044	32	DIO-SWITCHING
CR102	1902-0952	1	DIO-ZNR 5.6V 5%
CR112-119	1901-0518	8	DIO-SCHOTTKY
CR120	1901-1065	1	DIODE
CR123,202,321,322	1902-0783	4	DIO-ZNR 16V 5%
CR201,310,312	1902-0954	3	DIO-ZNR 6.8V 5%
CR401	1902-3094	1	DIO-ZNR 5.11V 2%
CR402	1902-0969	1	DIO-ZNR 30V 5%
CR403-406,408-410	1901-0620	7	DIO-SWITCHING
CR407	1901-0937	1	DIODE, SCHOTTKY
CR411	0837-0193	1	SUPPRESS-VOLTAGE
F401	2110-0001	1	FUSE-1AMP 250V
FH401	2110-0643	1	FUHLR-CLIP TYPE
J1	1252-2976	1	CONNECTOR-HEADER
J2	1252-3120	1	CONN-POST-11PIN
J3	1252-1325	1	CONN-POST-TP-HDR
J4	1252-0302	1	CONNECTOR
J5,6	1251-6429	2	CONN-POST-3PIN
J7	1252-0718	1	CONN-POST-5 PIN
J8	1252-0118	1	CONN-POST-TP-HDR
K401,402	0490-1696	2	RELAY 10A 30VDC
L301	9100-2265	1	INDCTR 10UH 10%
L401	9140-0983	1	INDUCTOR
L402	9140-0137	1	COIL-1000UH 5%
MP301, MP302	1400-0307	2	TIE WRAP
MP401	1205-0635	1	HEATSINK
MP402	1401-0219	1	F-CVR FUSE COVER

43131-66560 A2A2 Control Circuit Card Assembly (Continued)
See Figure 6-5 for Parts Breakdown

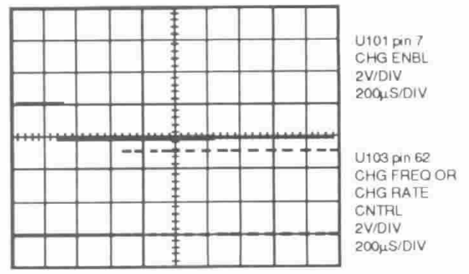
Reference Designator	Part Number	Qty	Description
P9	43131-61608	1	CBL AY-CHAS GND
P10	43131-61609	1	WIRE AY-ECG/APEX
P11	43131-61610	1	WIRE AY-ECG/STRN
P12	43131-61601	1	CBL AY-BAT/CONT
P13	43131-61600	1	CBL AY-PWR SPLY
Q101,104	1854-0215	2	XSTR-NPN SI
Q102	1853-0281	1	XSTOR 2N2907A
Q103,402	1853-0036	2	XSTR-2N3906
Q105,301,302	1854-0210	3	XSTR-NPN 2N2222
Q201,401	1855-0696	2	TRANSISTOR
Q403	1853-0058	1	XSTR-2N3644
R101,103,109,121,134-137, R309,310,407,408,418	0757-0280	13	RES-1K 1% .125W
R102,105,120,130-133,201, R204,311,313,316-318,320, R323,324,333,342,409,416, R417	0757-0442	22	RES-10K 1% .125
R104,114,405	0698-7933	3	RES 3.83 .1%
R106,107,112,113,314,315, R422,424	0698-3441	8	RES 215 1% .125W
R108,127,202	0757-0416	3	RES-.511K 1% .12
R110,111	0698-3157	2	RES 19.6K
R115,406,423	0699-0847	3	RES 1.96 .1%
R116-118,343,344	0698-3154	5	RES-4.22K 1% .12
R119,331	2100-0567	2	RES-TRMR 2K 10%
R122-124,412,415	0698-3458	5	RES-348K 1% .125
R125	0699-0272	1	RES-75K .1% .125
R126	0698-6942	1	RES 25K .1%
R128,401-404	0698-3446	5	RES 383 1% 125W
R129	0683-1065	1	RES 10M 5% .25W
R138	0686-3305	1	RES 33 5% 1/2W
R203	0757-0394	1	RES-51.1 OHM 1%
R205	1810-0269	1	NETWORK-RES SIP
R206-213	0698-3438	8	RES 147 1% .125W
R214,215,312	0698-0084	3	RES-2.15K 1% .12
R216	0757-0290	1	RES-6.19K 1% .12
R301-306	0689-1835	6	RES 18K 5% 1W
R307,308,325,326	0698-3460	4	RES-422K 1% .UIK
R319,341	0757-0465	2	RES-100K 1% .125
R321,322	0699-1993	2	RES-HV 33MEG 5%
R327,410	0698-8827	2	RESISTOR 1M
R328	2100-0558	1	RES-VAR 20K 10%
R329	0698-3260	1	RES 464K 1% .125
R330	0757-0439	1	RES 6.81K 1%
R332,336	0698-3158	2	RES-23.7K 1% .12
R334,420,426	0698-6343	3	RES 9K .1% .125W

43131-66560 A2A2 Control Circuit Card Assembly (Continued)
See Figure 6-5 for Parts Breakdown

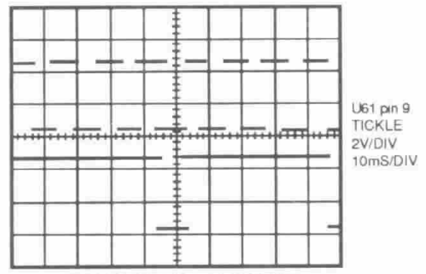
Reference Designator	Part Number	Qty	Description
R335	0698-3136	1	RES 17.8K 1%
R337	0757-0447	1	RES-16.2K 1% .12
R338	0698-3160	1	RES-31.6K 1% .12
R339,340	0757-0123	2	RES-34.8K 1% .12
R411	0698-8137	1	RES 9M 1% .125W
R413	0683-4745	1	RES 470K 5% .25W
R414	0698-8958	1	RESISTOR 511K
R419	0698-8695	1	RES 36K .1% .125
R421	0698-3266	1	RES-237K 1% .125
R425	0757-0274	1	RES-1.21K 1% .12
R427	0698-6348	1	RES-3K .1% .125W
R428	0811-3605	1	RES .1 5% .5W PW
R429	0757-0467	1	RES-121K 1% .125
R430	0683-1815	1	RES 180 5% .25W
R431	0698-4455	1	536 1% .125W
T301	43100-82730	1	XFMR, SIGNAL
T302	43100-82720	1	XFMR, PWR
U101	1820-6416	1	MICRO CONTROLLER
U102	1826-1248	1	IC-CONVERTER
U103	1820-5298	1	ASIC-COS-G-ARRAY
U104,301,306	1826-0785	3	IC OP AMP
U105	1820-2921	1	IC MM74HCO4N
U106	1820-3512	1	IC ULN2061M
U107	1820-3081	1	IC-MC74HC74N
U201,203	1820-3344	2	IC-MC74HC595N
U202	1820-2273	1	IC UDN2981A
U204	1858-0047	1	XSTR ARY 16P-D1P
U205	1820-3181	1	IC-MC74HC165N
U302,303	1826-0501	2	ANLG MUXR
U304	1826-1915	1	OP AMP
U305	1820-1315	1	IC-MC14051BCP
U401	1826-0412	1	IC 393
U402	1826-1258	1	IC TL431CLP
U403	1826-0718	1	IC MC1404U5
U404	1826-0393	1	IC LM317T
U405	1826-1257	1	IC +8V LIN REG
U406	1826-1256	1	IC SWTCHG REGLTR
U407	1826-0994	1	IC LM337LZ
* X101	5081-9529	1	SOCKET,IC
Y101	0410-1558	1	XTAL 12.00 MHZ
ZZ1	43131-86560	1	PC BD-DEF CONT
ZZ2	43131-84700	1	LABEL-BAR CODE



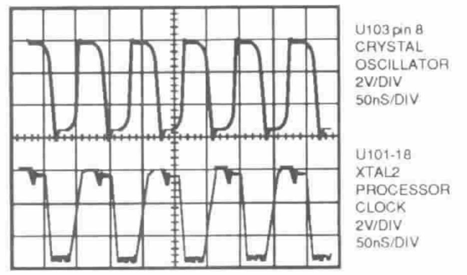
EXT. TRIG. ON U103 pin 2.

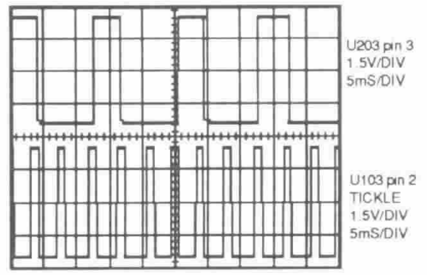


EXT. TRIG. ON U103 pin 61 SFTYRLY. SIGNAL PRESENT DURING CHARGE

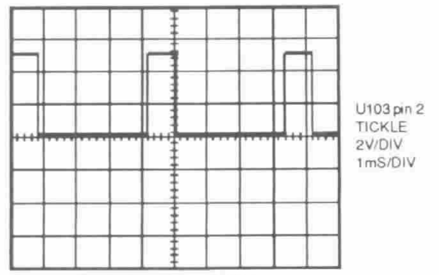


IF U61 FAILS TO TICKLE U62, THE RESET SIGNAL (CONRST) TO U61 pin 9 MAY LOOK LIKE EITHER OF THESE.

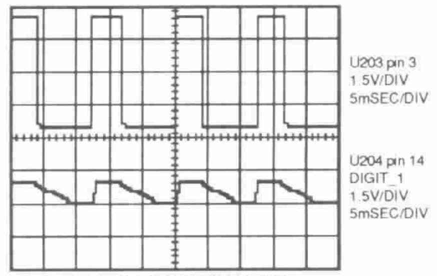




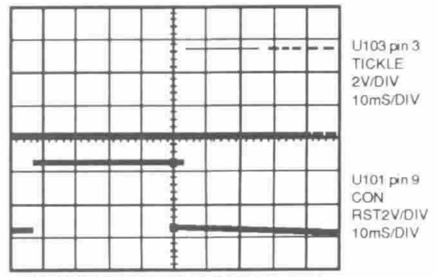
W/ "0" DISPLAYED ON FRONT PANEL DISPLAY



U103 OPERATING UNDER NORMAL CONDITIONS, SOFTWARE IS EXECUTED WHILE SIGNAL IS HIGH

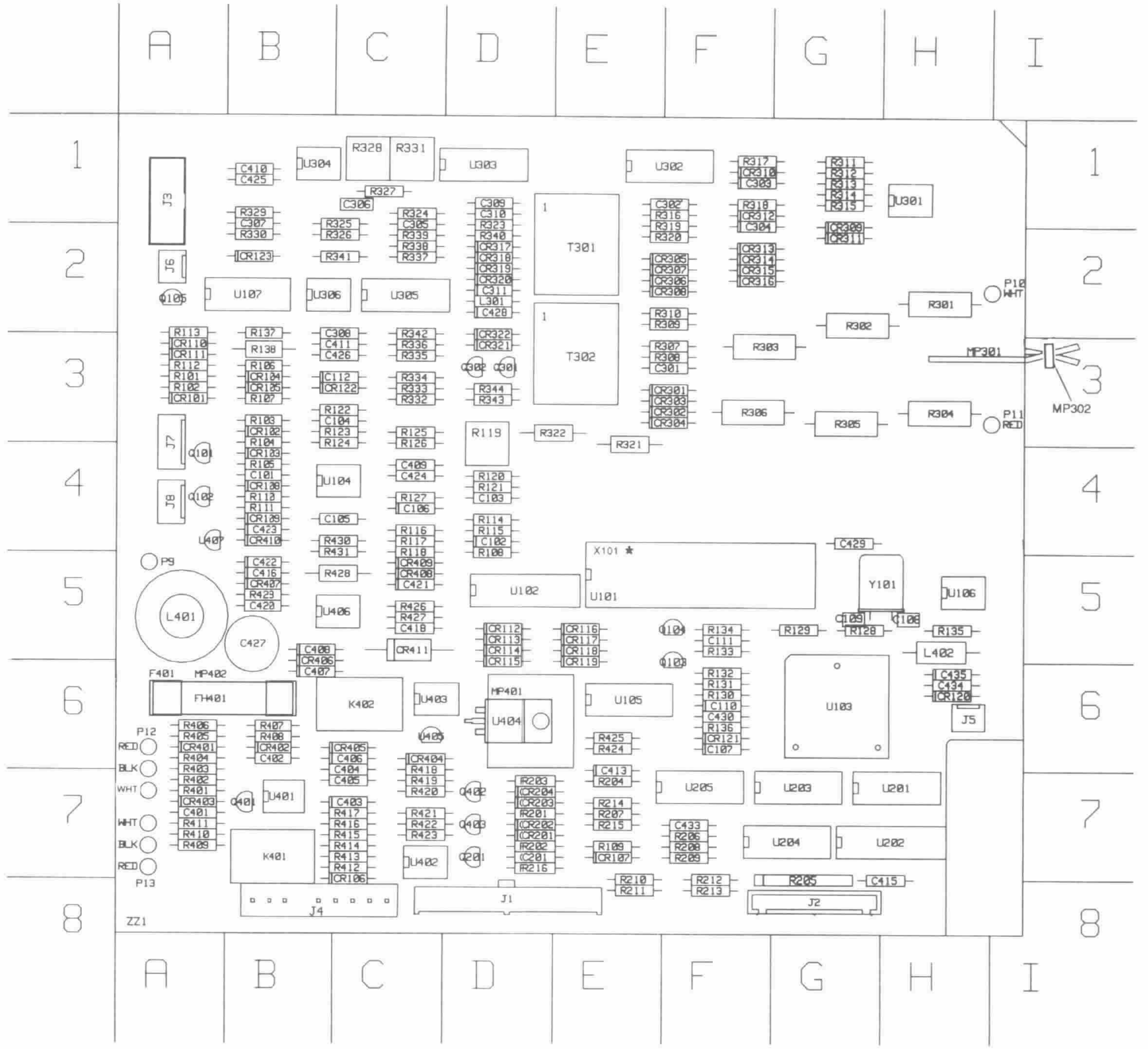


W/ "0" DISPLAYED ON FRONT PANEL



SEQUENCE OF EVENTS AT TURN-ON. EXT TRIGGERED ON SIQNAL"ON/OFF"

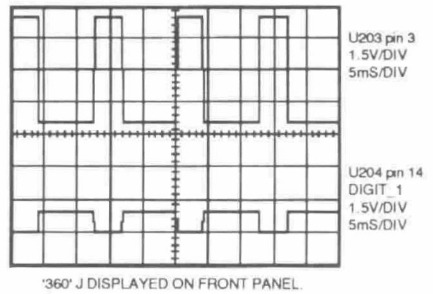
REF DESIG	GRID LOC	PART NUMBER
C101	B4	0160-5422
C102	D4	0180-3626
C103	D4	0160-4832
C104	B3	0160-4832
C105	B4	0160-4830
C106	C4	0180-3626
C107	F6	0180-3552
C108	H5	0160-3875
C109	G5	0160-3875
C110	F6	0180-3552
C111	F5	0160-5422
C112	B3	0180-3551
C201	D7	0160-3335
C301	E3	0160-4574
C302	E1	0160-5422
C303	F1	0180-3551
C304	F2	0180-3551
C305	C2	0160-6623
C306	C1	0160-4441
C307	B2	0160-4574
C308	B3	0160-4574
C309	D1	0160-5422
C310	D1	0160-5422
C311	D2	0180-3551
C401	A7	0160-4832
C402	B6	0160-6623
C403	C7	0180-3552
C404	C7	0160-6623
C405	C7	0160-4574
C406	C6	0180-3422
C407	B6	0180-3553
C408	B5	0180-3552
C409	C4	0160-5422
C410	B1	0160-5422
C411	B3	0160-5422
C413	E7	0180-3552
C415	G8	0160-5422
C416	B5	0180-3553
C418	C5	0160-5422
C420	B5	0160-4846
C421	C5	0180-3553
C422	B5	0180-3552
C423	B4	0180-3422
C424	C4	0160-5422
C425	B1	0160-5422
C426	B3	0160-5422
C427	B5	0180-4127
C428	D2	0180-3422
C429	G4	0160-5422
C430	F6	0160-5422
C433	F7	0160-5422
C434	H6	0160-5422
C435	H6	0180-3551
CR101	A3	1901-0044
CR102	B3	1902-0952
CR103	B4	1901-0044
CR104	B3	1901-0044
CR105	B3	1901-0044
CR106	C8	1901-0044
CR107	E7	1901-0044
CR108	B4	1901-0044
CR109	B4	1901-0044
CR110	A3	1901-0044
CR111	A3	1901-0044
CR112	D5	1900-0233
CR113	D5	1900-0233
CR114	D5	1900-0233
CR115	D6	1900-0233
CR116	E5	1900-0233
CR117	E5	1900-0233
CR118	E5	1900-0233
CR119	E6	1900-0233
CR120	H6	1901-0044
CR121	F6	1901-0044
CR122	B3	1901-0044
CR123	B2	1902-0783
CR201	D7	1902-0954
CR202	D7	1902-0783
CR203	D7	1901-0044
CR204	D7	1901-0044
CR301	E3	1901-0044
CR302	E3	1901-0044
CR303	E3	1901-0044
CR304	E3	1901-0044
CR305	E2	1901-0044
CR306	E2	1901-0044
CR307	E2	1901-0044
CR308	E2	1901-0044
CR309	G2	1901-0044
CR310	F1	1902-0954
CR311	G2	1901-0044
CR312	F1	1902-0954
CR313	F2	1901-0044
CR314	F2	1901-0044
CR315	F2	1901-0044
CR316	F2	1901-0044
CR317	D2	1901-0044
CR318	D2	1901-0044
CR319	D2	1901-0044
CR320	D2	1901-0044
CR321	D3	1902-0783
CR322	D3	1902-0783
CR401	A6	1902-3094
CR402	B6	1902-0969
CR403	A7	1901-0620
CR404	C6	1901-0620
CR405	C6	1901-0620
CR406	B6	1901-0620
CR407	B5	1901-0937
CR408	C5	1901-0620
CR409	C5	1901-0620
CR410	B4	1901-0620
CR411	C5	0837-0193
F401	A6	2110-0001
FH401	A6	2110-0643
J1	D8	1252-2976
J2	G8	1252-3120
J3	A1	1252-1325
J4	B8	1252-0302
J5	H6	1251-6429
J6	A2	1251-6429
J7	A4	1252-0718
J8	A4	1252-0118
K401	B7	0490-1696
K402	C6	0490-1696
L301	D2	9100-2265
L401	A5	9140-0983
L402	H5	9140-0137
MP301	H3	1400-0307
MP401	D6	1205-0635
MP402	A6	1401-0219
P10	I2	43131-61609
P11	I3	43131-61610
P12	A6	43131-61601
P13	A8	43131-61600
P9	A5	43131-61608
Q101	A4	1854-0215
Q102	A4	1853-0281
Q103	E5	1853-0036
Q104	E5	1854-0215
Q105	A2	1854-0210
Q201	D7	1855-0696
Q301	D3	1854-0210
Q302	D3	1854-0210
Q401	B7	1855-0696
Q402	D7	1853-0036
Q403	D7	1853-0058
R101	A3	0757-0280
R102	A3	0757-0442
R103	B3	0757-0280
R104	B4	0698-7933
R105	B4	0757-0442
R106	B3	0698-3441
R107	B3	0698-3441
R108	D5	0757-0416
R109	E7	0757-0280
R110	B4	0698-3157
R111	B4	0698-3157
R112	A3	0698-3441
R113	A3	0698-3441
R114	D4	0698-7933
R115	D4	0699-0847
R116	C4	0698-3154
R117	C4	0698-3154
R118	C5	0698-3154
R119	D3	2100-0567
R120	D4	0757-0442
R121	D4	0757-0280
R122	B3	0698-3458
R123	B3	0698-3458
R124	B4	0698-3458
R125	C3	0699-0272
R126	C4	0698-6942
R127	C4	0757-0416
R128	G5	0698-3446
R129	G5	0683-1065
R130	F6	0757-0442
R131	F6	0757-0442
R132	F6	0757-0442
R133	F5	0757-0442
R134	F5	0757-0280
R135	H5	0757-0280
R136	F6	0757-0280
R137	B3	0757-0280
R138	B3	0686-3305
R201	D7	0757-0442
R202	D7	0757-0416
R203	D7	0757-0394
R204	E7	0757-0442
R205	G8	1810-0269
R206	F7	0698-3438
R207	E7	0698-3438
R208	F7	0698-3438
R209	F7	0698-3438
R210	E8	0698-3438
R211	E8	0698-3438
R212	F8	0698-3438
R213	F8	0698-3438
R214	E7	0698-0084
R215	E7	0698-0084
R216	D7	0757-0290
R301	H2	0689-5625
R302	G2	0689-5625
R303	F3	0689-5625
R304	H3	0689-5625
R305	G3	0689-5625
R306	F3	0689-5625
R307	E3	0698-3451
R308	E3	0698-3451
R309	E2	0757-0280
R310	E2	0757-0280
R311	G1	0757-0442
R312	G1	0698-0084
R313	G1	0757-0442
R314	G1	0698-3441
R315	G1	0698-3441
R316	E1	0757-0442
R317	F1	0757-0442
R318	F1	0757-0442
R319	E2	0757-0465
R320	E2	0757-0442
R321	E4	0699-1993
R322	D3	0699-1993
R323	D2	0757-0442
R324	C1	0757-0442
R325	B2	0698-3460
R326	B2	0698-3460
R327	C1	0698-8827
R328	C1	2100-0558
R329	B1	0698-3260
R330	B2	0757-0439
R331	C1	2100-0567
R332	C3	0698-3158
R333	C3	0757-0442
R334	C3	0698-6343
R335	C3	0698-3136
R336	C3	0698-3158
R337	C2	0757-0447
R338	C2	0698-3160
R339	C2	0757-0123
R340	D2	0757-0123
R341	B2	0757-0465
R342	C3	0757-0442
R343	D3	0698-3154
R344	D3	0698-3154
R401	A7	0698-3446
R402	A7	0698-3446
R403	A7	0698-3446
R404	A6	0698-3446
R405	A6	0698-7933
R406	A6	0699-0847
R407	B6	0757-0280
R408	B6	0757-0280
R409	A7	0757-0442
R410	A7	0698-8827
R411	A7	0698-8137
R412	C7	0698-3458
R413	C7	0683-4745
R414	C7	0698-8958
R415	C7	0698-3458
R416	C7	0757-0442
R417	C7	0757-0442
R418	C7	0757-0280
R419	C7	0698-8695
R420	C7	0698-6343
R421	C7	0698-3266
R422	C7	0698-3441
R423	C7	0699-0847
R424	E6	0698-3441
R425	E6	0757-0274
R426	C5	0698-6343
R427	C5	0698-6348
R428	B5	0811-3605
R429	B5	0757-0467
R430	B4	0683-1815
R431	B5	0698-4455
T301	E2	43100-82730
T302	E3	43100-82720
U101	E5	1820-6416
U102	D5	1826-1248
U103	G6	1820-5298
U104	B4	1826-0785
U105	E6	1820-2921
U106	H5	1820-3512
U107	B2	1820-3081
U201	H7	1820-3344
U202	G7	1820-2273
U203	G7	1820-3344
U204	G7	1858-0047
U205	F7	1820-3181
U301	H1	1826-0785
U302	E1	1826-0501
U303	D1	1826-0501
U304	B1	1826-1915
U305	C2	1820-1315
U306	B2	1826-0785
U401	B7	1826-0412
U402	C7	1826-1258
U403	C6	1826-0718
U404	D6	1826-0393
U405	C6	1826-1257
U406	B5	1826-1256
U407	A4	1826-0994
Y101	G5	0410-1558
ZZ1	A8	43131-86560
ZZ2	F5	43131-84700
MP302	I3	1400-0307
* X101	E5	5081-9529

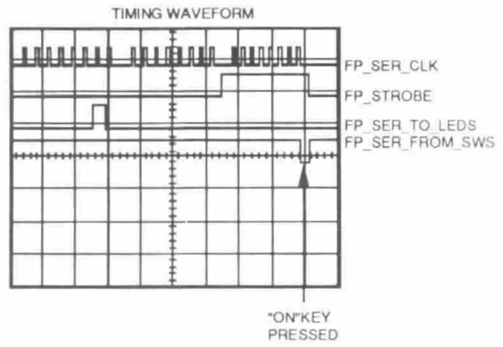


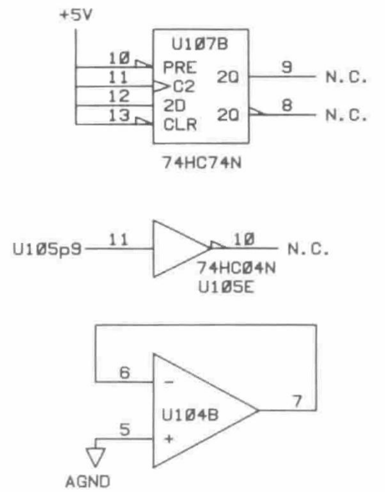
* X101 ONLY USED ON PREFIX 2942A

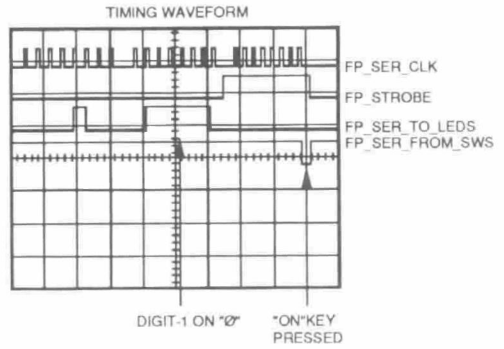
Figure 6-5. A2A2 Control Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 1 of 5).

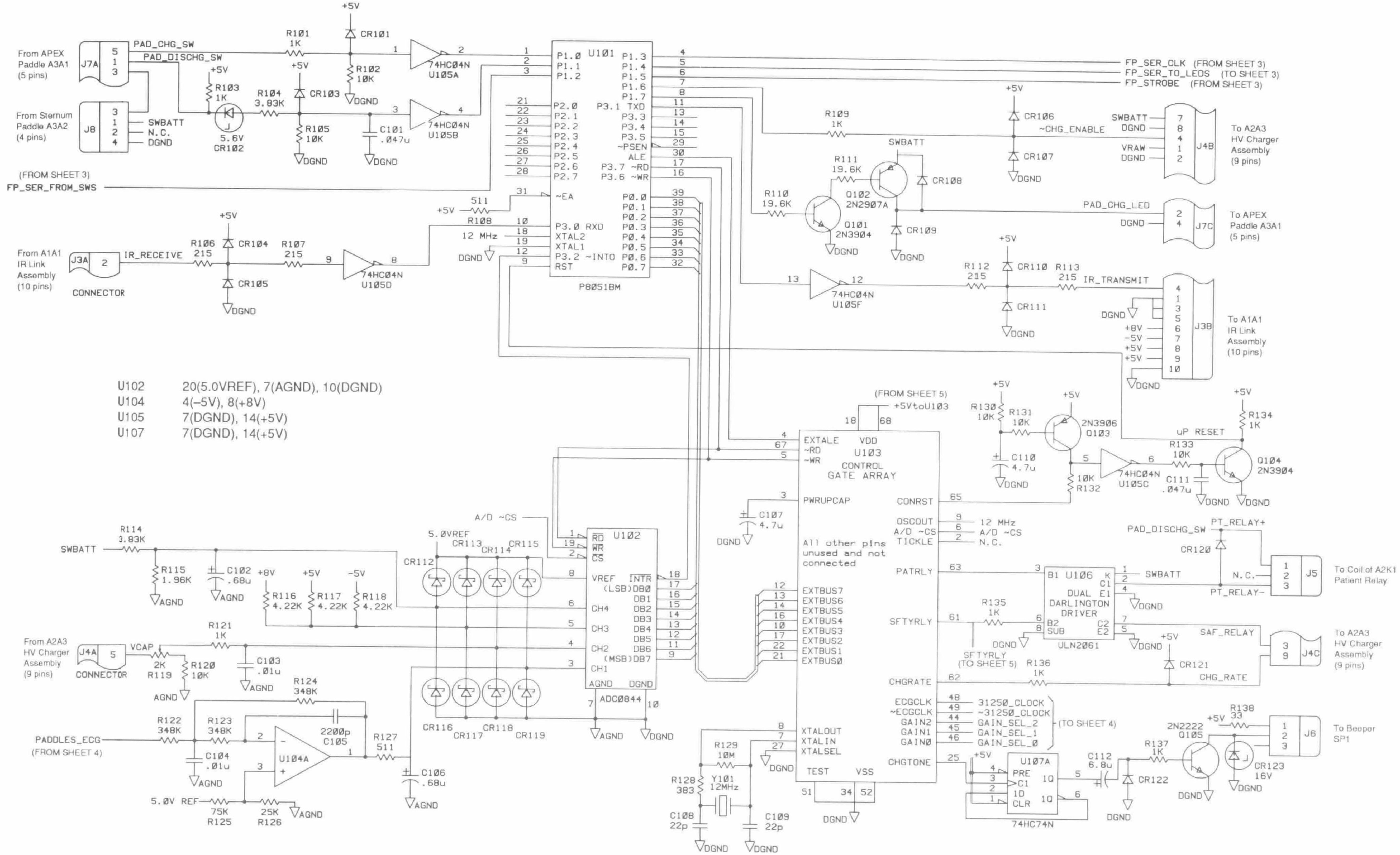
A2A2

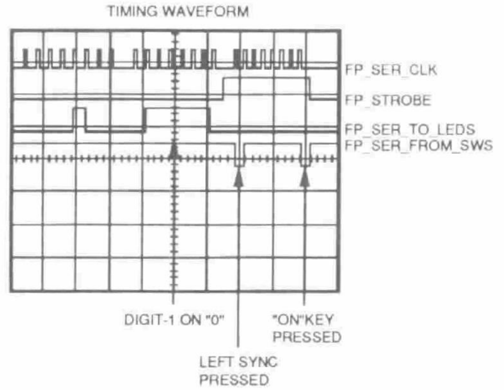





+5V
U107B
10
11
12
13
PRE
C2
2D
CLR
2Q
2Q
9
8
N.C.
N.C.
74HC74N
U105p9
11
10
N.C.
74HC04N
U105E
6
5
7
U104B
AGND




From APEX Paddle A3A1 (5 pins)
J7A
PAD_CHG_SW
PAD_DISCHG_SW
From Sternum Paddle A3A2 (4 pins)
J8
SWBATT
N.C.
DGND
R101 1K
R102 10K
R103 1K
R104 3.83K
R105 10K
CR101
CR102 5.6V
CR103
C101 .047u
74HC04N U105A
74HC04N U105B
(FROM SHEET 3)
FP_SER_FROM_SWS
From A1A1 IR Link Assembly (10 pins)
J3A
IR_RECEIVE
CONNECTOR
R106 215
R107 215
CR104
CR105
74HC04N U105D
U101
P1.0 P1.1 P1.2
P1.3 P1.4 P1.5 P1.6 P1.7
P2.0 P2.1 P2.2 P2.3 P2.4 P2.5 P2.6 P2.7
P3.1 TXD P3.3 P3.4 P3.5
~PSEN ALE P3.7 ~RD P3.6 ~WR
~EA
P0.0 P0.1 P0.2 P0.3 P0.4 P0.5 P0.6 P0.7
P3.0 RXD XTAL2 XTAL1 P3.2 ~INTO RST
R108
511
12 MHz
P8051BM
FP_SER_CLK (FROM SHEET 3)
FP_SER_TO_LEDS (TO SHEET 3)
FP_STROBE (FROM SHEET 3)
R109 1K
R110 19.6K
R111 19.6K
Q101 2N3904
Q102 2N2907A
CR106
CR107
CR108
CR109
~CHG_ENABLE
To A2A3 HV Charger Assembly (9 pins)
J4B
VRAW
PAD_CHG_LED
To APEX Paddle A3A1 (5 pins)
J7C
R112 215
R113 215
CR110
CR111
IR_TRANSMIT
74HC04N U105F
To A1A1 IR Link Assembly (10 pins)
J3B
+8V -5V +5V
U102 20(5.0VREF), 7(AGND), 10(DGND)
U104 4(-5V), 8(+8V)
U105 7(DGND), 14(+5V)
U107 7(DGND), 14(+5V)
(FROM SHEET 5)
+5VtoU103
U103
CONTROL GATE ARRAY
EXTALE ~RD ~WR
PWRUPCAP
All other pins unused and not connected
CONRST
OSCOUT
A/D ~CS
TICKLE
PATRLY
SFTYRLY
CHGRATE
ECGCLK ~ECGCLK GAIN2 GAIN1 GAIN0
CHGTONE
EXTBUS7 EXTBUS6 EXTBUS5 EXTBUS4 EXTBUS3 EXTBUS2 EXTBUS1 EXTBUS0
XTALOUT XTALIN XTALSEL
TEST VSS
C107 4.7u
R128 383
R129 10M
Y101 12MHz
C108 22p
C109 22p
R130 10K
R131 10K
2N3906 Q103
C110 4.7u
R132 10K
74HC04N U105C
R133 10K
C111 .047u
uP RESET
R134 1K
Q104 2N3904
PAD_DISCHG_SW
PT_RELAY+
PT_RELAY-
CR120
U106 DUAL DARLINGTON DRIVER ULN2061
To Coil of A2K1 Patient Relay
J5
R135 1K
SFTYRLY (TO SHEET 5)
R136 1K
SAF_RELAY
CHG_RATE
CR121
To A2A3 HV Charger Assembly (9 pins)
J4C
31250_CLOCK
~31250_CLOCK
GAIN_SEL_2
GAIN_SEL_1
GAIN_SEL_0
(TO SHEET 4)
U107A 74HC74N
C112 6.8u
CR122
R137 1K
2N2222 Q105
R138 33
CR123 16V
To Beeper SP1
J6
A/D ~CS
U102 ADC0844
RD WR CS
VREF
CH4 CH3 CH2 CH1
(LSB)DB0 DB1 DB2 DB3 DB4 DB5 DB6 (MSB)DB7
INTR
AGND DGND
5.0VREF
CR112 CR113 CR114 CR115
CR116 CR117 CR118 CR119
SWBATT
R114 3.83K
R115 1.96K
C102 .68u
R116 4.22K
R117 4.22K
R118 4.22K
From A2A3 HV Charger Assembly (9 pins)
J4A
VCAP
CONNECTOR
R119 2K
R120 10K
R121 1K
C103 .01u
R124 348K
PADDLES_ECG (FROM SHEET 4)
R122 348K
R123 348K
C104 .01u
C105 2200p
U104A
R127 511
C106 .68u
5.0V REF
R125 75K
R126 25K
AGND
DGND



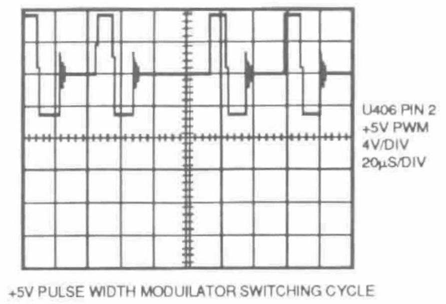
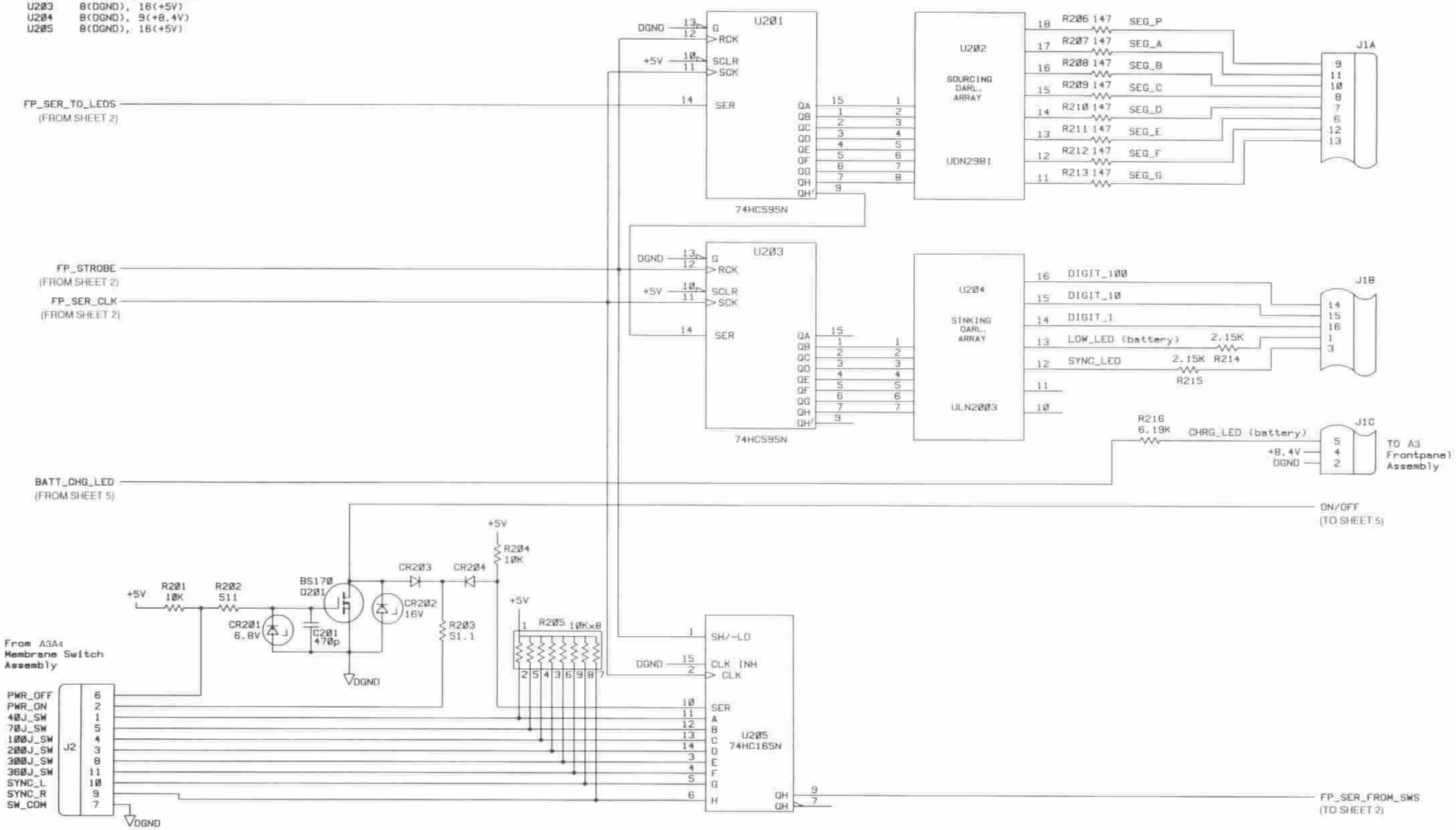


Figure 6-5. A2A2 Control Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 2 of 5).

```
PINS CONNECTED TO EMBEDDED POWER/GROUND NETS:
U201    8(DGND), 16(+5V)
U202    9(+8.4V), 10(DGND)
U203    8(DGND), 16(+5V)
U204    8(DGND), 9(+8.4V)
U205    8(DGND), 16(+5V)
```



FP_SER_TO_LEDS
(FROM SHEET 2)
FP_STROBE
(FROM SHEET 2)
FP_SER_CLK
(FROM SHEET 2)
BATT_CHG_LED
(FROM SHEET 5)
DGND
+5V
U201
G
RCK
SCLR
SCK
SER
QA
QB
QC
QD
QE
QF
QG
QH
QH'
74HC595N
U202
SOURCING DARL. ARRAY
UDN2981
R206 147
R207 147
R208 147
R209 147
R210 147
R211 147
R212 147
R213 147
SEG_P
SEG_A
SEG_B
SEG_C
SEG_D
SEG_E
SEG_F
SEG_G
J1A
U203
74HC595N
U204
SINKING DARL. ARRAY
ULN2003
DIGIT_100
DIGIT_10
DIGIT_1
LOW_LED (battery)
SYNC_LED
2.15K
2.15K R214
R215
J1B
R216
6.19K
CHRG_LED (battery)
+8.4V
DGND
J1C
TO A3 Frontpanel Assembly
ON/OFF
(TO SHEET 5)
+5V
R204
10K
CR203
CR204
BS170
Q201
R201
10K
R202
511
CR201
6.8V
C201
470p
CR202
16V
R203
51.1
R205 10Kx8
DGND
From A3A4 Membrane Switch Assembly
PWR_OFF
PWR_ON
40J_SW
70J_SW
100J_SW
200J_SW
300J_SW
360J_SW
SYNC_L
SYNC_R
SW_COM
J2
SH/-LD
CLK INH
CLK
SER
A
B
C
D
E
F
G
H
U205
74HC165N
QH
QH
FP_SER_FROM_SWS
(TO SHEET 2)

Figure 6-5. A2A2 Control Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 3 of 5).

A2A2

TIE-WRAP	1400-0307	MP301

```
PINS CONNECTED TO EMBEDDED POWER/GROUND NETS:
U301     4(-6V), 8(+6V)
U302     7(-6V), 8(-6V), 16(+6V)
U303     7(-5V), 8(AGND), 16(+5VF)
U304     4(-5V), 7(+8V)
U305     7(-5V), 8(AGND), 16(+5VF)
U306     4(-5V), 8(+8V)
```

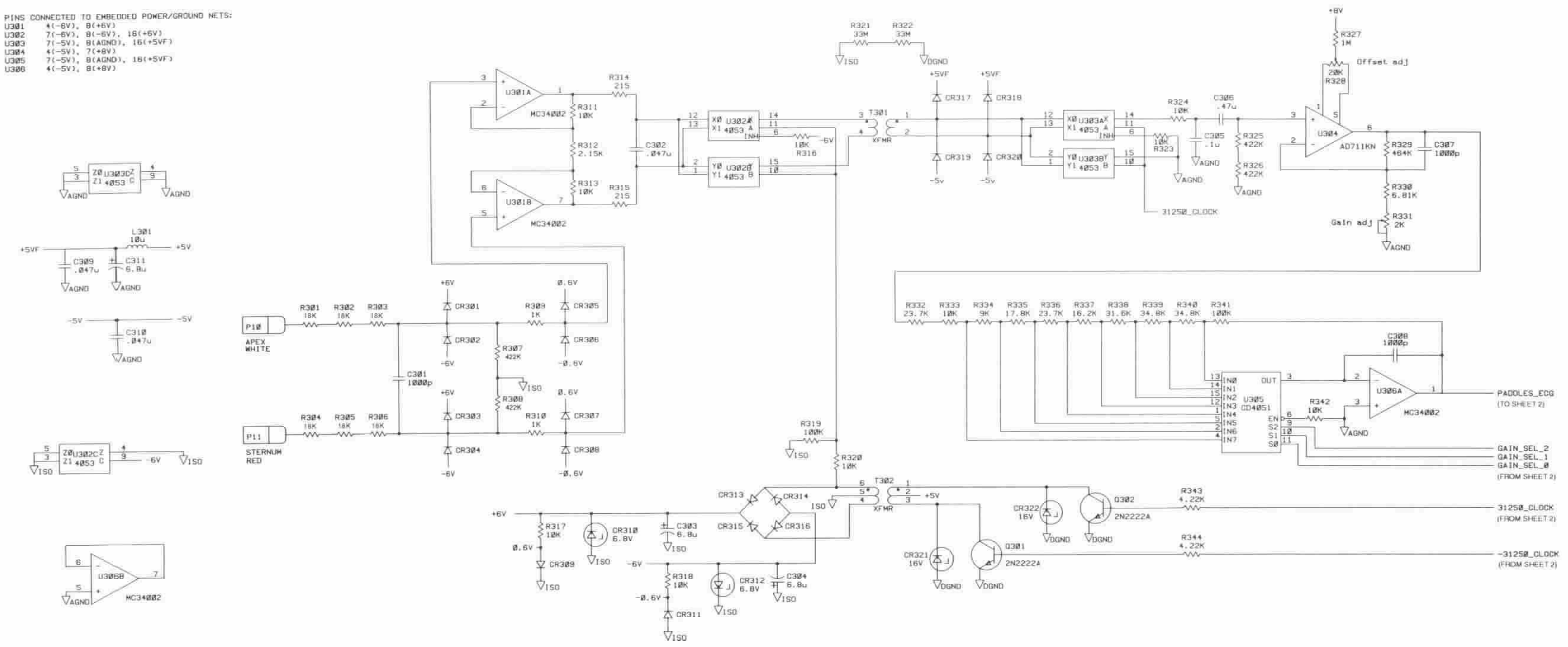

U303C 4053
AGND
L301 10u
+5VF
+5V
C309 .047u
C311 6.8u
-5V
C310 .047u
U302C 4053
-6V
ISO
U306B
MC34002
P10
APEX WHITE
P11
STERNUM RED
R301 18K
R302 18K
R303 18K
R304 18K
R305 18K
R306 18K
C301 1000p
+6V
CR301
CR302
CR303
CR304
R307 422K
R308 422K
R309 1K
R310 1K
0.6V
-0.6V
CR305
CR306
CR307
CR308
U301A
U301B
MC34002
R311 10K
R312 2.15K
R313 10K
R314 215
R315 215
C302 .047u
U302A 4053
U302B 4053
R316 10K
INH
R319 100K
R320 10K
R321 33M
R322 33M
DGND
T301
XFMR
+5VF
CR317
CR318
CR319
CR320
U303A 4053
U303B 4053
31250_CLOCK
R323 10K
R324 10K
C306 .47u
C305 .1u
R325 422K
R326 422K
+8V
R327 1M
R328 20K
Offset adj
U304
AD711KN
R329 464K
C307 1000p
R330 6.81K
R331 2K
Gain adj
R332 23.7K
R333 10K
R334 9K
R335 17.8K
R336 23.7K
R337 16.2K
R338 31.6K
R339 34.8K
R340 34.8K
R341 100K
C308 1000p
U305 CD4051
IN0 IN1 IN2 IN3 IN4 IN5 IN6 IN7
OUT EN S2 S1 S0
R342 10K
U306A
MC34002
PADDLES_ECG
(TO SHEET 2)
GAIN_SEL_2
GAIN_SEL_1
GAIN_SEL_0
(FROM SHEET 2)
T302
XFMR
CR313
CR314
CR315
CR316
R317 10K
CR310 6.8V
C303 6.8u
CR309
R318 10K
CR312 6.8V
C304 6.8u
CR311
CR321 16V
CR322 16V
Q301 2N2222A
Q302 2N2222A
R343 4.22K
R344 4.22K
31250_CLOCK
-31250_CLOCK
(FROM SHEET 2)

Figure 6-5. A2A2 Control Circuit Card Assembly
Component Locator and Schematic Diagram
(Sheet 4 of 5).

A2A2

HEAT SINK for U404	1205-0635	MP401
FUSE COVER	1401-0219	MP402
FUSEHOLDER	2110-0643	FH401
UNLOADED PC BOARD	43131-86560	ZZ1
BARCODE LABEL	43131-84700	ZZ2

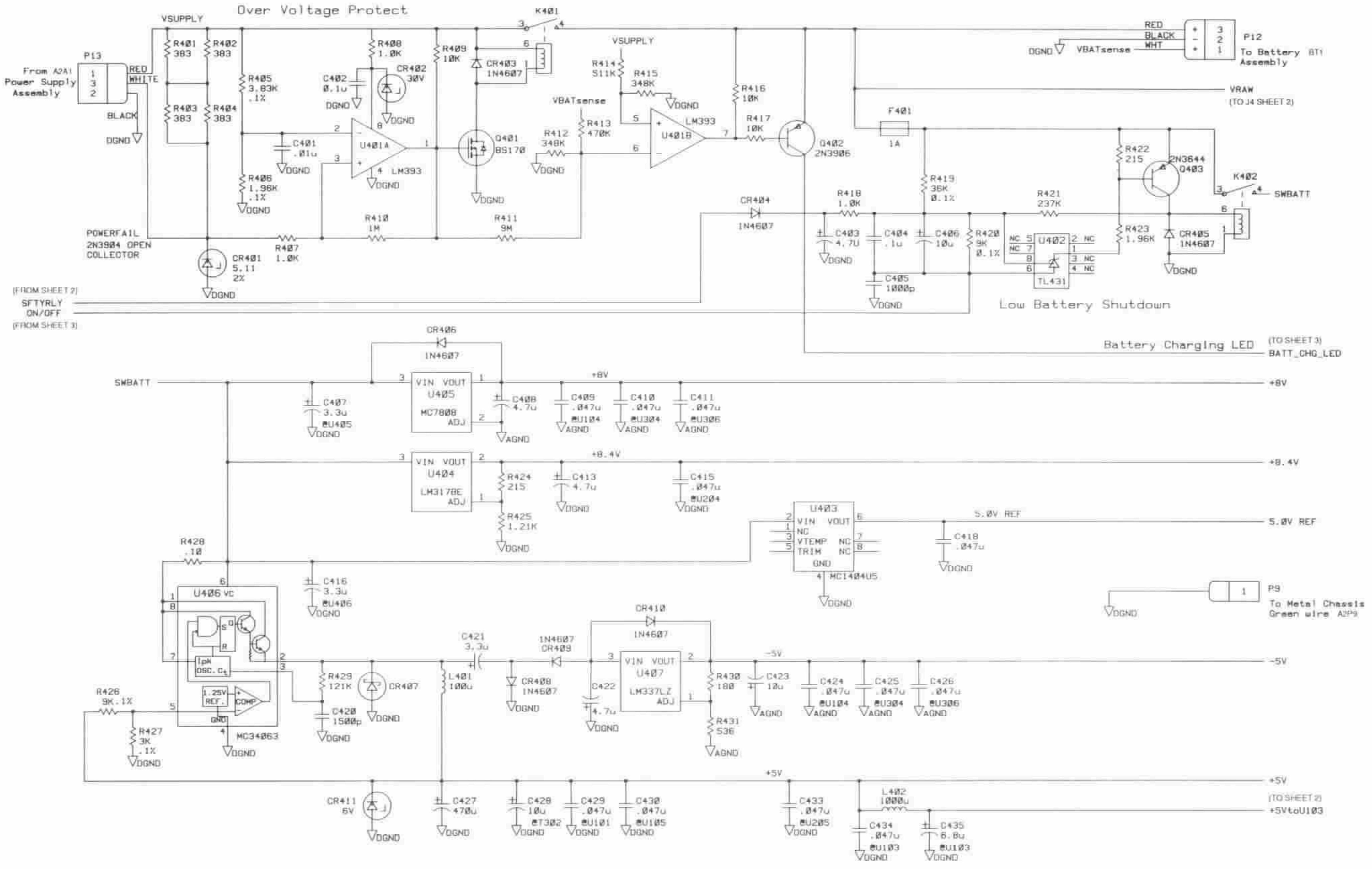

Over Voltage Protect
VSUPPLY
From A2A1 Power Supply Assembly
P13
RED
WHITE
BLACK
DGND
R401 383
R402 383
R403 383
R404 383
R405 3.83K .1%
R406 1.96K .1%
POWERFAIL 2N3904 OPEN COLLECTOR
R407 1.0K
CR401 5.11 2X
C401 .01u
C402 0.1u
U401A
LM393
R408 1.0K
CR402 30V
R409 10K
CR403 1N4607
R410 1M
R411 9M
Q401 BS170
K401
VSUPPLY
R414 511K
R415 348K
VBATsense
R412 348K
R413 470K
U401B
LM393
R416 10K
R417 10K
Q402 2N3906
F401 1A
R418 1.0K
CR404 1N4607
C403 4.7U
C404 .1u
C405 1000p
C406 10u
R419 36K 0.1%
R420 9K 0.1%
R421 237K
U402
TL431
R422 215
R423 1.96K
2N3644 Q403
CR405 1N4607
K402
SWBATT
P12
To Battery BT1 Assembly
VBATsense
VRAW
(TO J4 SHEET 2)
Low Battery Shutdown
Battery Charging LED
(TO SHEET 3)
BATT_CHG_LED
(FROM SHEET 2)
SFTYRLY
ON/OFF
(FROM SHEET 3)
CR406 1N4607
SWBATT
C407 3.3u @U405
U405 MC7808
+8V
C408 4.7u
C409 .047u @U104
C410 .047u @U304
C411 .047u @U306
AGND
+8V
U404 LM317BE
+8.4V
R424 215
R425 1.21K
C413 4.7u
C415 .047u @U204
+8.4V
U403 MC1404U5
VIN VOUT
NC
VTEMP
TRIM
GND
5.0V REF
C418 .047u
5.0V REF
R428 .10
C416 3.3u @U406
U406 VC
MC34063
Ipk OSC. Ct
1.25V REF.
COMP
R426 9K.1%
R427 3K .1%
R429 121K
C420 1500p
CR407
C421 3.3u
L401 100u
1N4607 CR409
CR408 1N4607
C422 4.7u
CR410 1N4607
U407 LM337LZ
R430 180
R431 536
-5V
C423 10u
C424 .047u @U104
C425 .047u @U304
C426 .047u @U306
-5V
P9
To Metal Chassis Green wire A2P9
+5V
CR411 6V
C427 470u
C428 10u @T302
C429 .047u @U101
C430 .047u @U105
C433 .047u @U205
L402 1000u
C434 .047u @U103
C435 6.8u @U103
+5V
(TO SHEET 2)
+5VtoU103

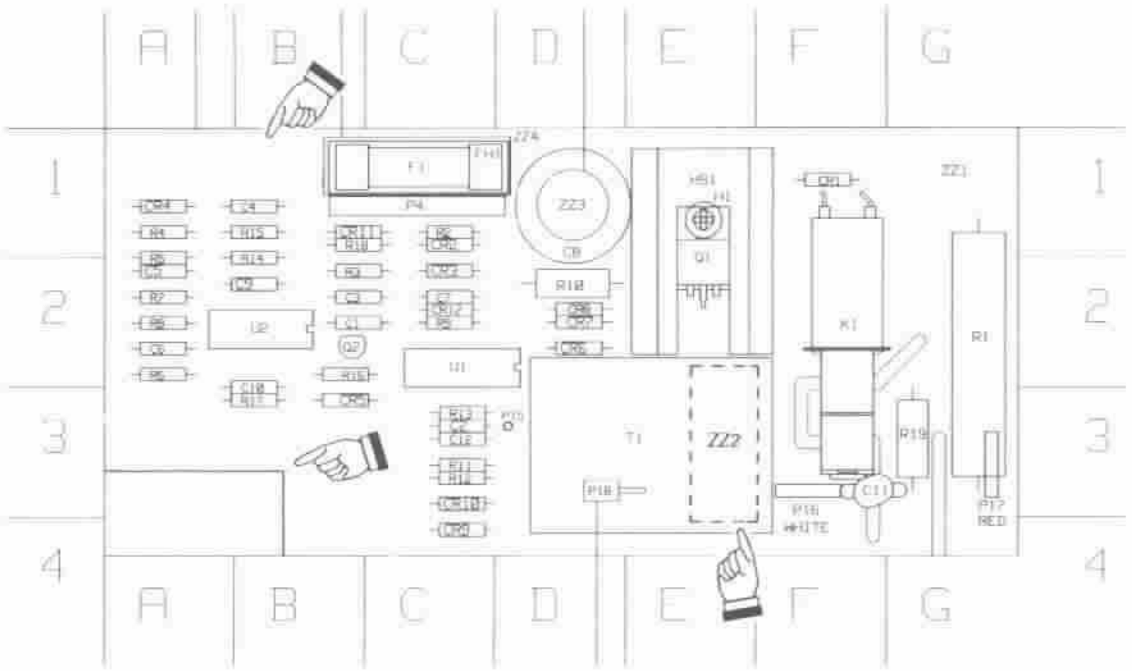
Figure 6-5. A2A2 Control Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 5 of 5).

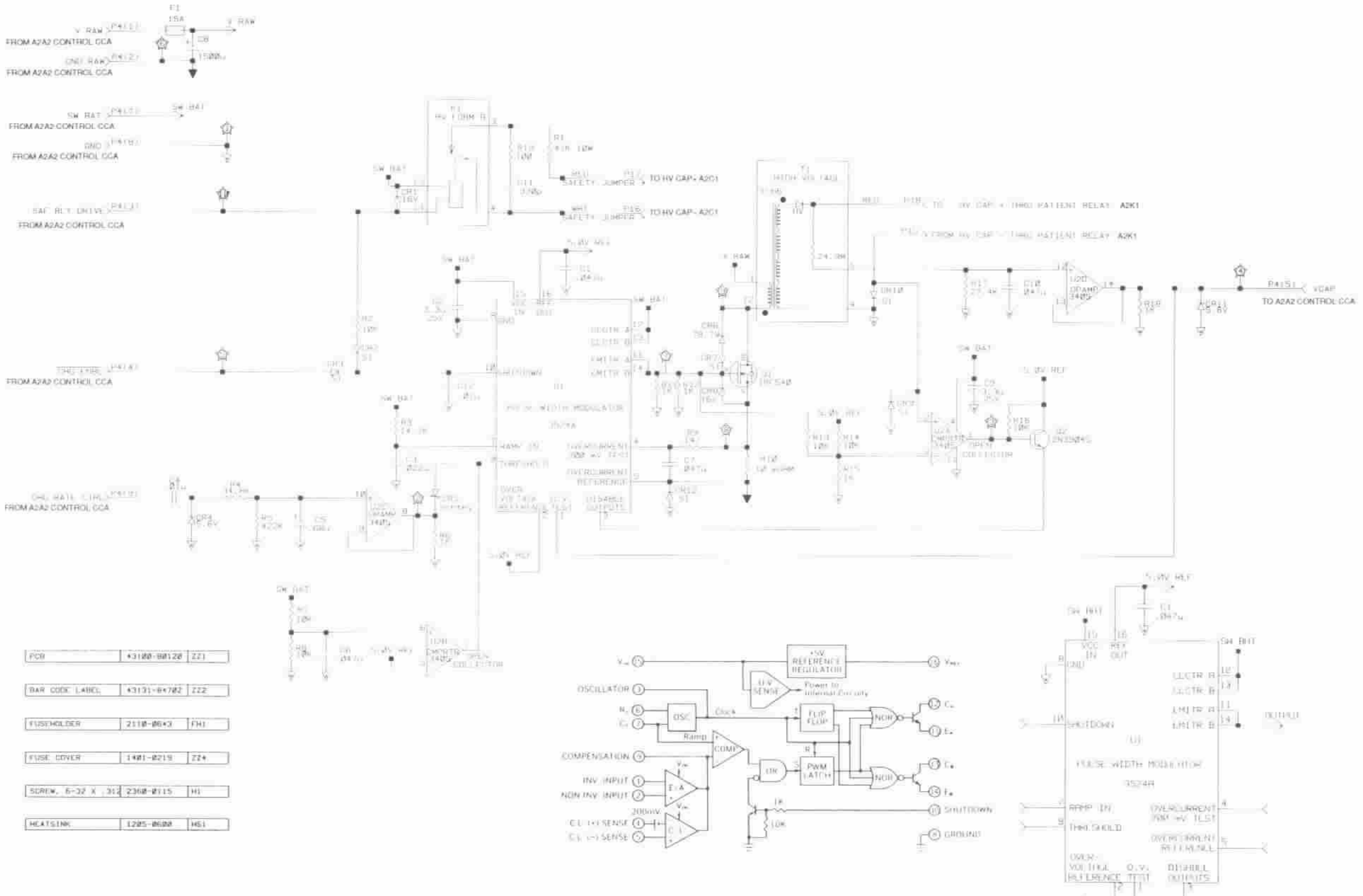
A2A2

43131-66580 A2A3 High Voltage Capacitor Charger Circuit Card Assembly
See Figure 6-6 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
C1,6,7,10	0160-5422	4	CAP .047UF 20%
C2,9	0180-3553	2	CAP-FIXED 3.3UF
C3	0160-4918	1	CAP .022UF 10%
C4,12	0160-4832	2	CAP .01UF 10%
C5	0180-3626	1	C-F .68UF 25V TA
C8	0180-2997	1	C-F 1500UF 25V
C11	0160-5605	1	HI VOLT CAP
CR1,8	1902-0783	2	DIO-ZNR 16V 5%
CR2,3,7	1901-0044	3	DIO-SWITCHING
CR4,11	1902-0952	2	DIO-ZNR 5.6V 5%
CR5	1901-0518	1	DIO-SCHOTTKY
CR6	1902-3400	1	DIO-ZNR 78.7V
CR9,10,12	1901-0620	3	DIO-SWITCHING
F1	2110-0048	1	FUSE-15A 32V
FH1	2110-0643	1	FUHLR-CLIP TYPE
H1	2360-0115	1	SCR-BH 6-32X.312
HS1	1205-0600	1	HEAT SINK
K1	43100-82870	1	HV RELAY
P4	43131-61616	1	CBL AY-HV CHGR
P15	1251-0600	1	CONTACT-CONN M
P16	43131-61614	1	WIRE ASSY-WHITE
P17	43131-61613	1	WIRE ASSY-RED
Q1	1855-0590	1	XSTR,PWR MOSFET
Q2	1854-0215	1	XSTR-NPN SI
R1	0811-3706	1	RESISTOR, FIXED
R2,7,8,13,14,16	0757-0442	6	RES-10K 1% .125
R3	0698-3156	1	RES 14.7K 1%
R4	0757-0123	1	RES-34.8K 1% .12
R5	0698-3460	1	RES-422K 1% .UIK
R6,11,12,15,18	0757-0280	5	RES-1K 1% .125W
R9	0698-3438	1	RES 147 1% .125W
R10	0811-3705	1	RESISTOR, FIXED
R17	0698-8804	1	RES 27.4K .1%
R19	0689-1015	1	RES 100 5% 1W CC
T1	43100-62700	1	XFMR HV
U1	1826-1050	1	IC UC3524A-N
U2	1826-0424	1	IC 3405
ZZ1	43100-80120	1	PC BOARD
ZZ2	43131-84702	1	LABEL-BAR CODE
ZZ4	1401-0219	1	F-CVR FUSE COVER

REF DESIG	GRID LOC	PART NUMBER
C1	B2	0160-5422
C2	C3	0180-3553
C3	B2	0160-4918
C4	B1	0160-4832
C5	A2	0180-3626
C6	A2	0160-5422
C7	C2	0160-5422
C8	D1	0180-2997
C9	B2	0180-3553
C10	B3	0160-5422
C11	F3	0160-5605
C12	C3	0160-4832
CR1	F1	1902-0783
CR2	C1	1901-0044
CR3	C2	1901-0044
CR4	A1	1902-0952
CR5	B3	1900-0233
CR6	D2	1902-3400
CR7	D2	1901-0044
CR8	D2	1902-0783
CR9	C4	1901-0620
CR10	C3	1901-0620
CR11	B1	1902-0952
CR12	C2	1901-0620
F1	C1	2110-0048
FH1	C1	2110-0643
H1	E1	2360-0115
HS1	C1	1205-0600
K1	F2	43100-82870
P4	C1	43131-61616
P15	D3	1251-0600
P16	G3	43131-61614
P17	F3	43131-61613
Q1	E2	1855-0590
Q2	B2	1854-0215
R1	G2	0811-3706
R2	C1	0757-0442
R3	B2	0698-3156
R4	A1	0757-0123
R5	A2	0698-3460
R6	A2	0757-0200
R7	A2	0757-0442
R8	A2	0757-0442
R9	C2	0698-3438
R10	D2	0811-3705
R11	C3	0757-0280
R12	C3	0757-0200
R13	C3	0757-0442
R14	B2	0757-0442
R15	B1	0757-0280
R16	B2	0757-0442
R17	B3	0698-8604
R18	B1	0757-0280
R19	G3	0689-1015
T1	E3	43100-82700
U1	C2	1826-1050
U2	B2	1826-0424
ZZ1	G1	43100-80120
ZZ2	A2	43131-84702
ZZ3	D1	43131-84503
ZZ4	C1	1401-0219


A
B
C
D
E
F
G
1
2
3
4
ZZ4
F1
FH1
ZZ3
HS1
H1
Q1
CR1
ZZ1
P4
CR4
R4
R5
C5
R7
R8
R6
C6
C4
R15
R18
CR11
R2
CR2
C3
R3
R14
C9
C1
Q2
R16
C10
R17
CR5
U2
U1
R9
CR3
CR12
R10
C8
CR6
CR7
CR8
K1
R1
R12
C2
R11
R13
C12
CR10
CR9
P15
T1
ZZ2
P16
C11
R19
P17
WHITE
RED


FROM A2A2 CONTROL CCA
V RAW
GND RAW
F1
15A
C8
1500μ
SW BAT
GND
SAF RLY DRIVE
THRESHOLD
CHG RATE CTRL
K1
HV FORM B
TO HV CAP+ A2C1
SAFETY JUMPER
T1
HIGH VOLTAGE
TO HV CAP + THRU PATIENT RELAY A2K1
FROM HV CAP - THRU PATIENT RELAY A2K1
5.0V REF
V RAW
U2C
OP AMP
340
P4(5)
VCAP
TO A2A2 CONTROL CCA
Q2
2N3904S
U2A
COMPTR
3405
OPEN COLLECTOR
U1
PULSE WIDTH MODULATOR
3524A
CLCTR A
CLCTR B
EMITR A
EMITR B
RAMP IN
THRESHOLD
OVERCURRENT 200 mV TEST
OVERCURRENT REFERENCE
OVER-VOLTAGE REFERENCE
O.V. TEST
DISABLE OUTPUTS
Q1
IRF540
U2B
COMPTR
3405
U2D
COMPTR
3405
+5V REFERENCE REGULATOR
U.V. SENSE
Power to Internal Circuitry
OSCILLATOR
OSC
Clock
FLIP FLOP
NOR
Ramp
COMP
E/A
INV INPUT
NON INV INPUT
200mV
C.L. (+) SENSE
C.L. (-) SENSE
OR
PWM LATCH
COMPENSATION
SHUTDOWN
GROUND
VCC IN
REF OUT
OUTPUT

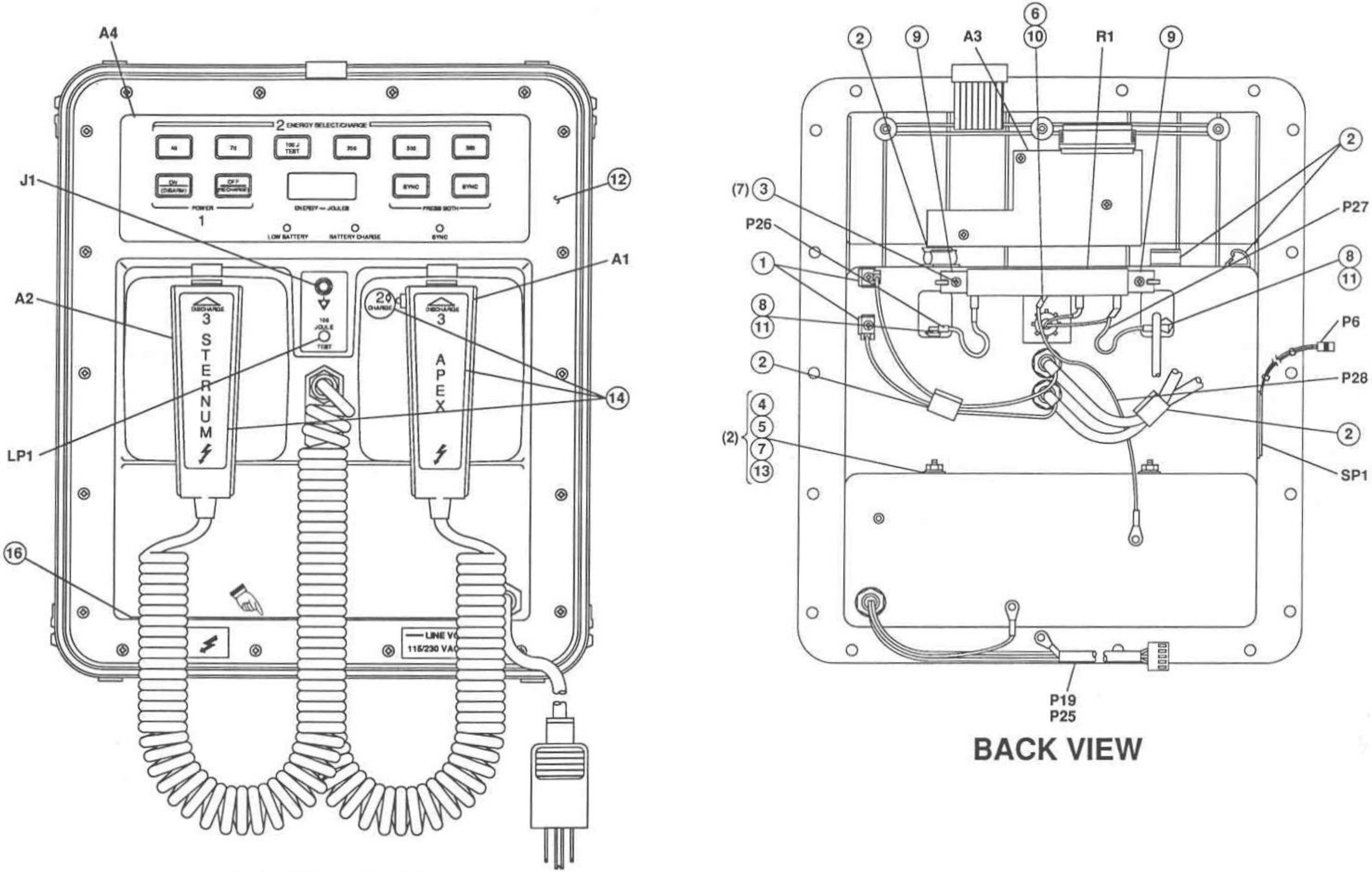
PCB	43100-80120	ZZ1
BAR CODE LABEL	43131-84702	ZZ2
FUSEHOLDER	2110-0643	FH1
FUSE COVER	1401-0219	ZZ4
SCREW, 6-32 X .312	2360-0115	H1
HEATSINK	1205-0600	HS1

Figure 6-6. A2A3 High Voltage Capacitor Charger Circuit Card Assembly Component Locator and Schematic Diagram.

A2A3

43131-67201 A3 Front Panel Assembly
See Figure 6-7 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43131-60400	1	PDL SET-APEX
A2	43131-60401	1	PDL SET-STERNUM
A3	43131-66570	1	PC AY-CONT DISP
A4	43131-67200	1	SW PNL-MEMBRANE
J1	1510-0038	1	BINDING POST-SGL
LP1	1450-0651	1	NEON LAMP
P6	43131-61606	1	CBL AY-SPEAKER
P19	43131-61602	1	CBL AY-AC PWR
P25	43131-61603	1	CBL AY-PS AC
P26	43131-61604	1	CBL AY-PDL CONT
P27	43131-61605	1	CBL AY-PDL CONT
P28	43131-61607	1	CBL AY-GND TERM
R1	0811-3832	1	RES-TPD
SP1	9160-0292	1	SPEAKER
6-7-1	0360-2233	2	TERMINAL
6-7-2	1400-1549	5	CABLE CLAMP
6-7-3	2360-0113	7	PHMS-6-32X.25 P
6-7-4	2510-0168	2	BHMS 8-32X.38
6-7-5	2580-0017	2	NUT-W/LKWSR 8-32
6-7-6	2950-0071	1	NUT-HEX 1/4-32
6-7-7	3050-0938	2	WSHR-FLAT 8
6-7-8	43131-07309	2	PADDLE CONTACT
6-7-9	43131-07310	2	RESISTOR MOUNT
6-7-10	43131-27301	1	ACORN NUT 1/4-32
6-7-11	43131-46701	2	PADDLE CON SEAL
6-7-12	43131-47205	1	PANEL-FRONT
6-7-13	43131-47300	2	PADDLE RETAINER
6-7-14	43131-84500	1	LBL SET-FRNT PNL
6-7-15	78620-00849	1	WASHER
6-7-16	43131-84505	1	LABEL, INFORMATION
	0890-0561	3	TBG-HS .187-DIA
	0890-1274	1	TUBING-FLEX
	1400-0307	1	TIE WRAP


A4
J1
A2
LP1
⑯
⑫
A1
⑭
2 ENERGY SELECT/CHARGE
ON (DISARM)
OFF (RECHARGE)
POWER
1
ENERGY — JOULES
SYNC
SYNC
PRESS BOTH
LOW BATTERY
BATTERY CHARGE
SYNC
DISCHARGE
3
STERNUM
APEX
100 JOULE TEST
2 CHARGE
LINE VO
115/230 VAC
②
⑨
A3
⑥
⑩
R1
⑨
②
(7) ③
P26
P27
①
⑧
⑪
⑧
⑪
P6
②
P28
(2) ④ ⑤ ⑦ ⑬
②
SP1
P19
P25

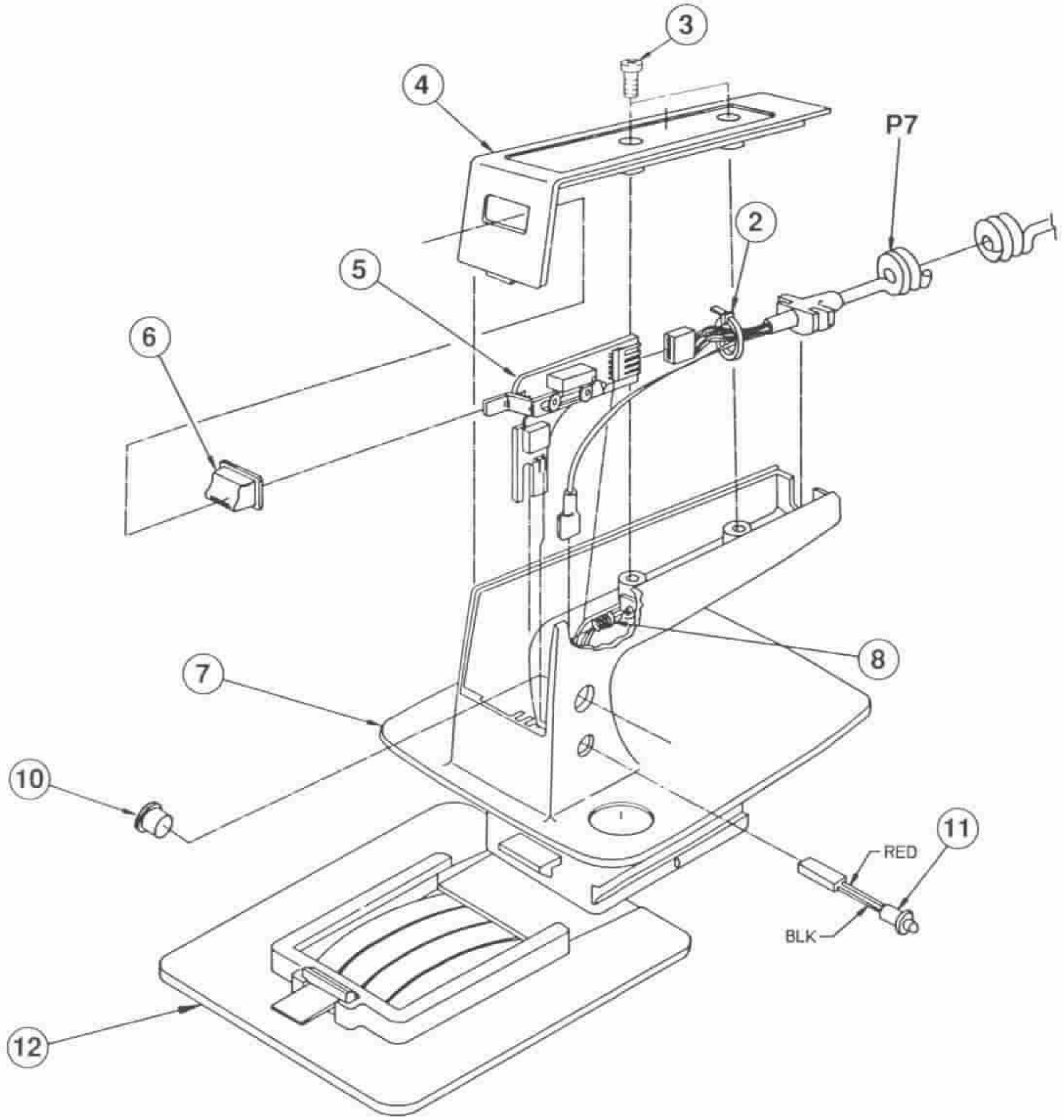
FRONT VIEW

BACK VIEW

Figure 6-7. A3 Front Panel Assembly Component Locator.

43131-60400 A3A1 Apex Paddle Assembly
See Figure 6-8 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
P7	43131-61611	1	CBL-COIL,APEX
6-8-1			Not used.
6-8-2	1400-0307	1	TIE WRAP
6-8-3	2200-0107	2	PHMS 4-40X.375
6-8-4	43100-47118	1	COVER-PDL
6-8-5	43100-60125	1	PC AY PDL SWTCH
6-8-6	43100-47121	1	BUTTN-DISCHARGE
6-8-7	43100-47114	1	PDL-APEX
6-8-8	43100-87400	1	SPRING
6-8-9			Not used.
6-8-10	43100-47120	1	BUTTON-CHG
6-8-11	43100-63000	1	PDL-LT ASSY
6-8-12	43100-60400	1	ADULT PDL ASSY


3
4
P7
2
5
6
7
8
10
11
RED
BLK
12

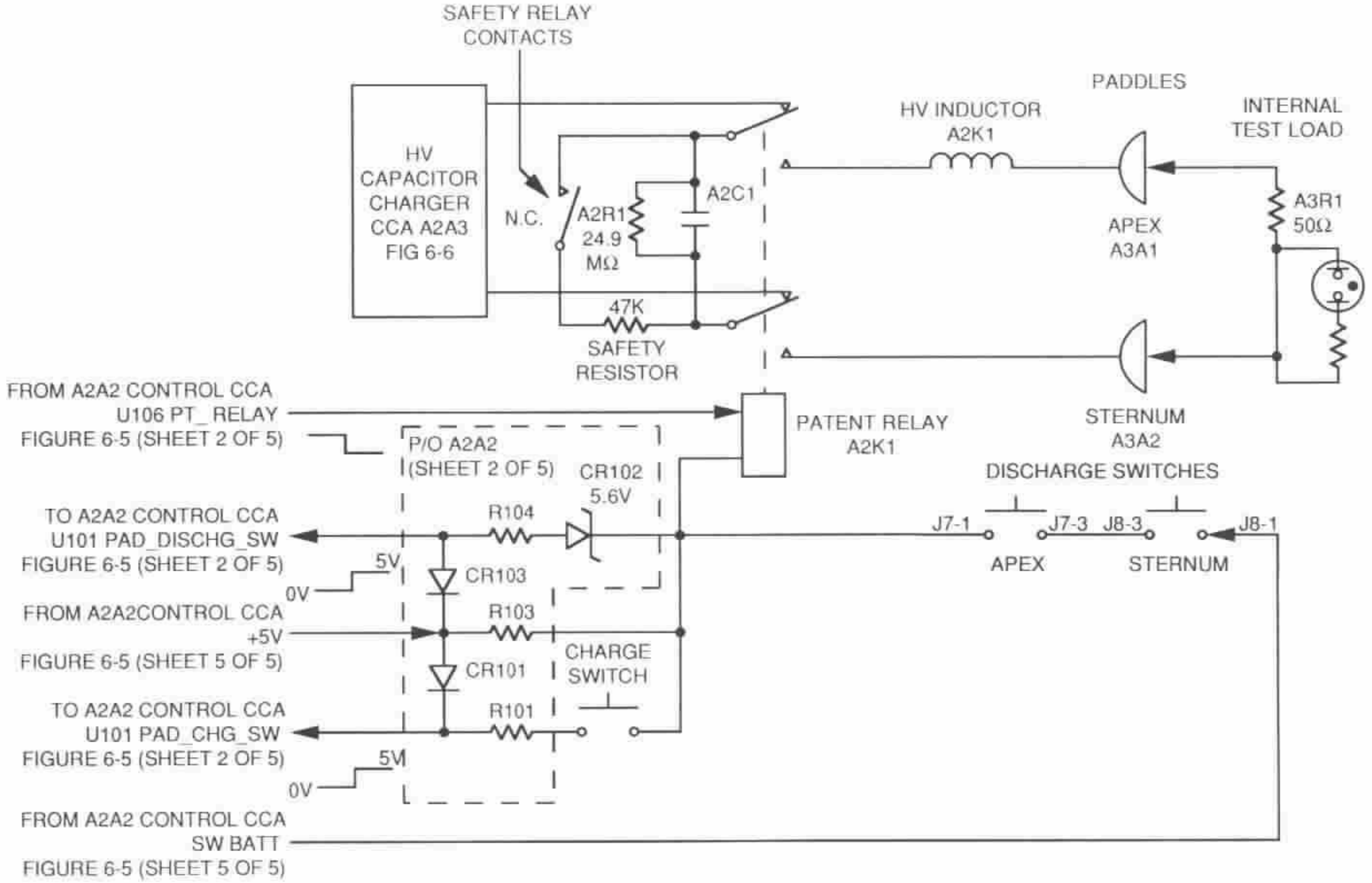

SAFETY RELAY CONTACTS
HV CAPACITOR CHARGER CCA A2A3 FIG 6-6
N.C.
A2R1 24.9 MΩ
A2C1
47K
SAFETY RESISTOR
HV INDUCTOR A2K1
PADDLES
INTERNAL TEST LOAD
A3R1 50Ω
APEX A3A1
STERNUM A3A2
PATENT RELAY A2K1
DISCHARGE SWITCHES
J7-1
J7-3
J8-3
J8-1
APEX
STERNUM
FROM A2A2 CONTROL CCA U106 PT_ RELAY FIGURE 6-5 (SHEET 2 OF 5)
P/O A2A2 (SHEET 2 OF 5)
CR102 5.6V
R104
TO A2A2 CONTROL CCA U101 PAD_DISCHG_SW FIGURE 6-5 (SHEET 2 OF 5)
5V
0V
CR103
R103
FROM A2A2CONTROL CCA +5V FIGURE 6-5 (SHEET 5 OF 5)
CHARGE SWITCH
CR101
R101
TO A2A2 CONTROL CCA U101 PAD_CHG_SW FIGURE 6-5 (SHEET 2 OF 5)
5V
0V
FROM A2A2 CONTROL CCA SW BATT FIGURE 6-5 (SHEET 5 OF 5)

Figure 6-8. A3A1 Apex Paddle Assembly Exploded View.

**43131-60401 A3A2 Sternum Paddle Assembly
See Figure 6-9 for Parts Breakdown**

Reference Designator	Part Number	Qty	Description
P8	43131-61612	1	CBL-COIL,STERNUM
6-9-1			Not used.
6-9-2	1400-0307	1	TIE WRAP
6-9-3	2200-0107	2	PHMS 4-40X.375
6-9-4	43100-47118	1	COVER-PDL
6-9-5	43100-60135	1	PC AY-PDL SW
6-9-6	43100-47121	1	BUTTN-DISCHARGE
6-9-7	43100-47122	1	PDL W/O DISPLAY
6-9-8	43100-87400	1	SPRING
6-9-9	43100-60400	1	ADULT PDL ASSY

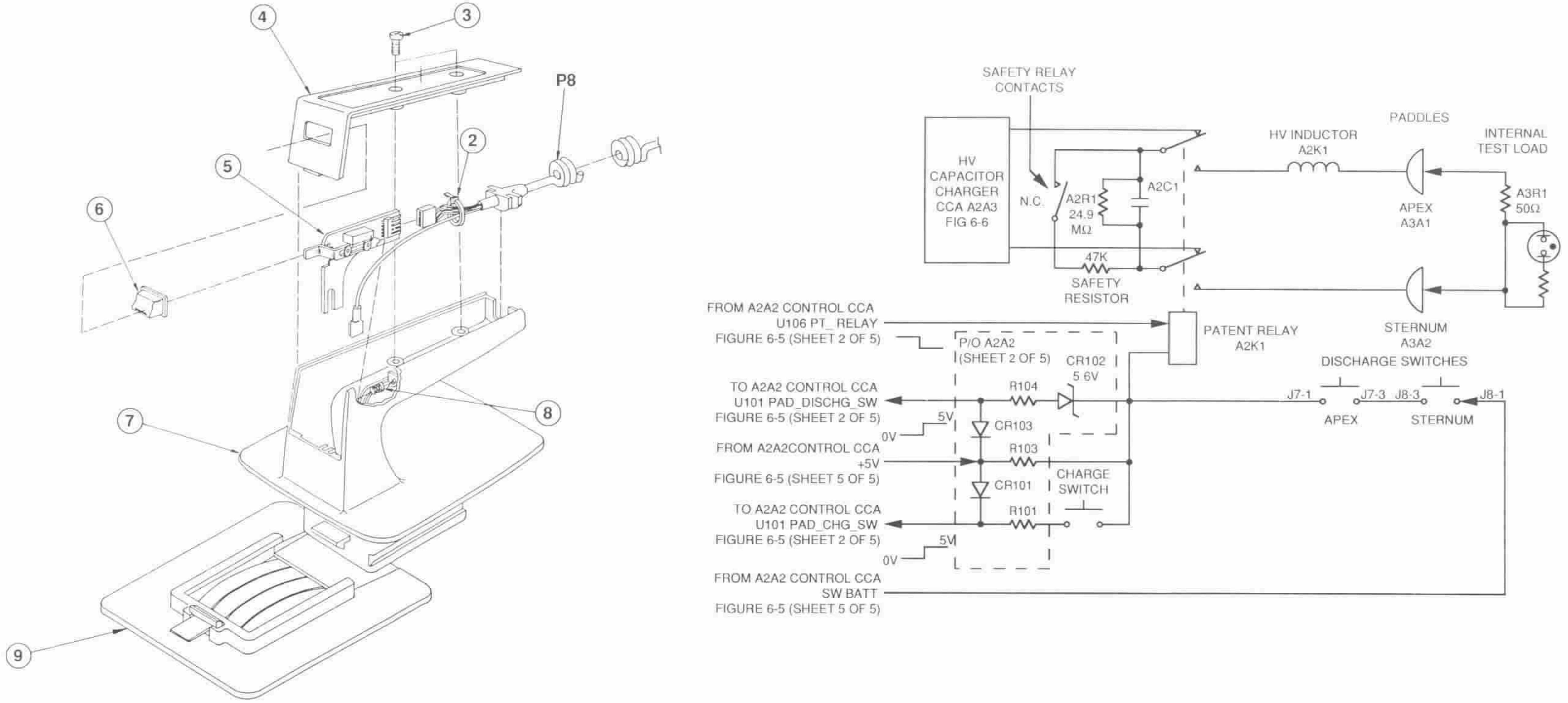

4
3
P8
2
5
6
7
8
9
SAFETY RELAY CONTACTS
PADDLES
HV INDUCTOR A2K1
INTERNAL TEST LOAD
HV CAPACITOR CHARGER CCA A2A3 FIG 6-6
N.C.
A2R1 24.9 MΩ
A2C1
APEX A3A1
A3R1 50Ω
47K
SAFETY RESISTOR
FROM A2A2 CONTROL CCA U106 PT_ RELAY FIGURE 6-5 (SHEET 2 OF 5)
PATENT RELAY A2K1
STERNUM A3A2
P/O A2A2 (SHEET 2 OF 5)
CR102 5 6V
DISCHARGE SWITCHES
TO A2A2 CONTROL CCA U101 PAD_DISCHG_SW FIGURE 6-5 (SHEET 2 OF 5)
R104
J7-1
J7-3
J8-3
J8-1
APEX
STERNUM
5V
0V
CR103
FROM A2A2CONTROL CCA +5V FIGURE 6-5 (SHEET 5 OF 5)
R103
CHARGE SWITCH
CR101
TO A2A2 CONTROL CCA U101 PAD_CHG_SW FIGURE 6-5 (SHEET 2 OF 5)
R101
5V
0V
FROM A2A2 CONTROL CCA SW BATT FIGURE 6-5 (SHEET 5 OF 5)

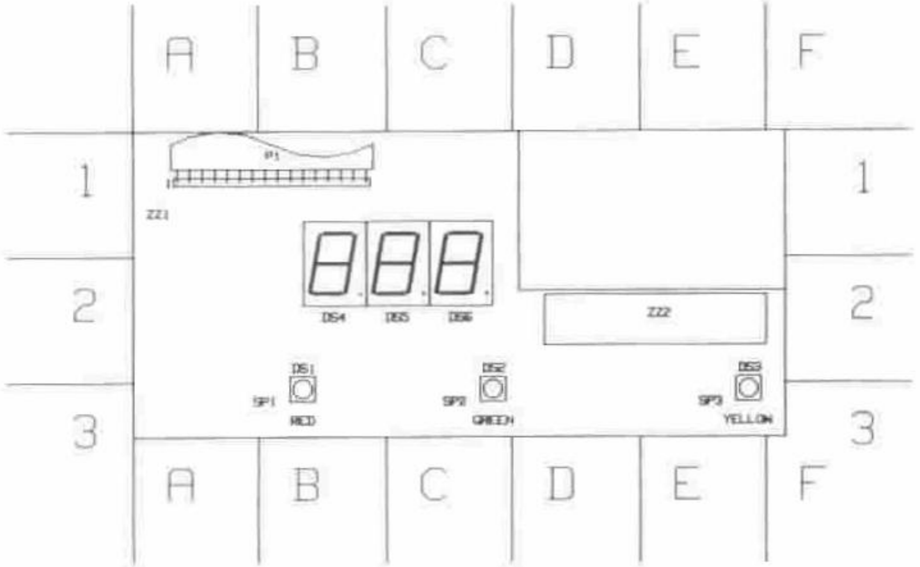
Figure 6-9. A3A1 Sternum Paddle Assembly Exploded View.

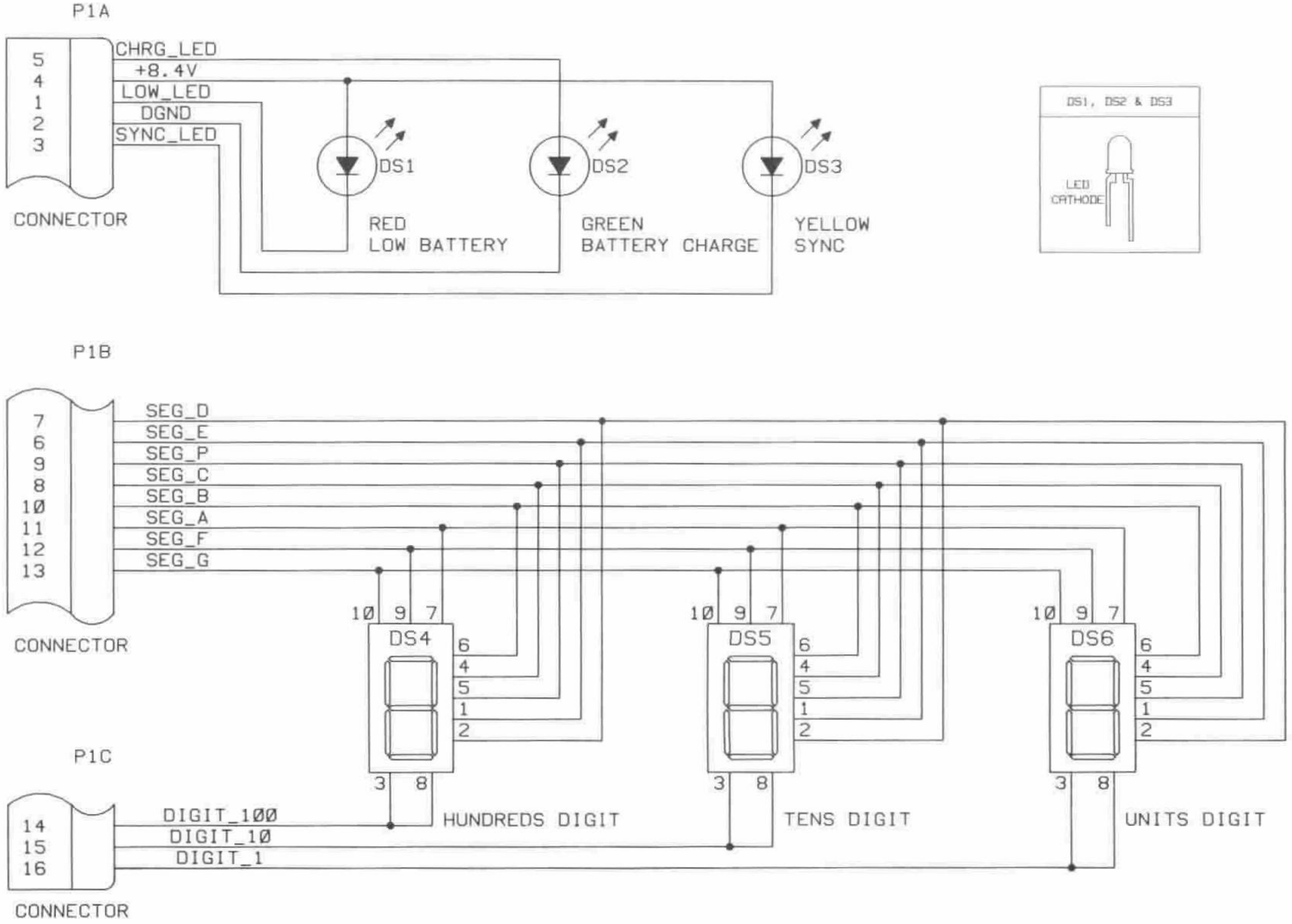
43131-66570 A3A3 Display Circuit Card Assembly
See Figure 6-10 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
DS1	1990-0958	1	LED-LMP
DS2	1990-1293	1	LED-LMP
DS3	1990-0957	1	LED-LMP
DS4-6	1990-1107	3	LED-DISPLAY
P1	8120-5272	1	CBL-FLAT RIBBON
SP1-3	0340-1221	3	SPACER-COMPONENT
ZZ1	43131-86570	1	PC BD-CONT DSPL
ZZ2	43131-84701	1	LABEL-BAR CODE

PCB	43131-86570	ZZ1
BAR CODE LABEL	43131-84701	ZZ2
LED SPACER	0340-1221	SP1-3

REF DESIG	GRID LOC	PART NUMBER
DS1	B2	1990-0958
DS2	C2	1990-1293
DS3	E2	1990-0957
DS4	B2	1990-1107
DS5	B2	1990-1107
DS6	C2	1990-1107
P1	B1	8120-5272
SP1	A3	0340-1221
SP2	C3	0340-1221
SP3	E3	0340-1221
ZZ1	A1	43131-86570
ZZ2	E2	43131-84701


A
B
C
D
E
F
1
2
3
P1
ZZ1
DS4
DS5
DS6
ZZ2
DS1
SP1
RED
DS2
SP2
GREEN
DS3
SP3
YELLOW


P1A
5
4
1
2
3
CHRG_LED
+8.4V
LOW_LED
DGND
SYNC_LED
CONNECTOR
DS1
RED
LOW BATTERY
DS2
GREEN
BATTERY CHARGE
DS3
YELLOW
SYNC
P1B
7
6
9
8
10
11
12
13
SEG_D
SEG_E
SEG_P
SEG_C
SEG_B
SEG_A
SEG_F
SEG_G
CONNECTOR
10 9 7
DS4
6
4
5
1
2
3 8
HUNDREDS DIGIT
10 9 7
DS5
6
4
5
1
2
3 8
TENS DIGIT
10 9 7
DS6
6
4
5
1
2
3 8
UNITS DIGIT
P1C
14
15
16
DIGIT_100
DIGIT_10
DIGIT_1
CONNECTOR

DS1, DS2 & DS3
LED
CATHODE

Figure 6-10. A3A3 Display Circuit Card Assembly Component Locator and Schematic Diagram.

For more information, call your local HP office or East (301) 948-6370 Midwest (312) 255-9800 South (404) 955-1500 West (213) 877-1282; or write: Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304. In Europe, Hewlett-Packard S.A., 7, rue du Bois-du-lan, P. O. Box CH-1217, Meyrin 2, Geneva, Switzerland. In Japan, Yokogawa-Hewlett-Packard Ltd., 29-21, Takaido-Higashi 3-chome, Suginami-ku, Tokyo 168.

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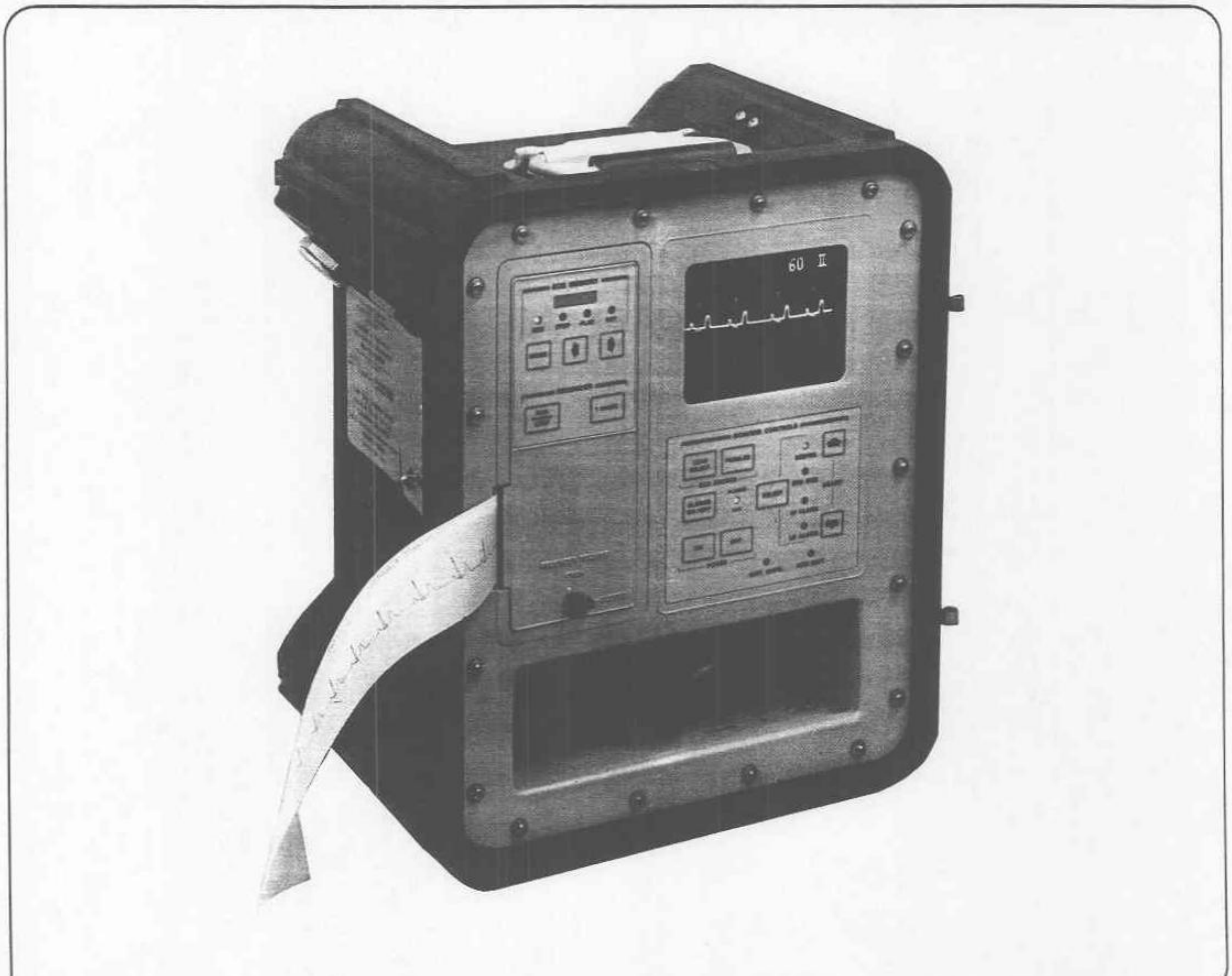
43200M/MC/MD MONITOR-RECORDER MODULE



SERVICE MANUAL

HEWLETT
PACKARD

43200M/MC/MD
MONITOR-RECORDER MODULE

SERVICE MANUAL

PART NUMBER 43201-91909

This manual applies to instruments with serial number prefix through 2943A.

Second Edition

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March 1990

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WARRANTY

Hewlett-Packard (HP) warrants this medical product against defects in materials and workmanship for a period of one (1) year from date of shipment.

If HP receives notices of such defects during the warranty period, HP shall at its option either repair or replace hardware products which prove to be defective.

PLACE OF PERFORMANCE

Defective hardware is to be shipped, freight prepaid, to:

Hewlett-Packard Company, McMinnville Division
1700 S. Baker St.
McMinnville, Oregon 97128

Attention DEPMEDS Warranty Services, Return Authorization #30001484

All warranty repairs will be performed by HP or by a subcontractor authorized by HP to act in its behalf.

Repaired hardware will be shipped, freight prepaid, to the specified CONUS location.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from:

- Improper or inadequate maintenance by users,
- Unauthorized modification or misuse, or
- Operation outside of the environmental specification for the product.

THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND NO OTHER WARRANTY, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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The foregoing limitation of liability shall not apply in the event that any HP product sold hereunder is determined by a court of competent jurisdiction to be defective and to have directly caused bodily injury, death or property damage; provided, that in no event shall HP's liability for property damage exceed the greater of $50,000 or the purchase price of the specific product that caused such damage.

SAFETY

GENERAL

This module and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the main power source to the individual instruments input wiring terminals, power cord, or supplied power cord set.

WARNINGS

Any interruption of the protective (grounding) conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.) In addition, verify that a common ground exists between the unit under test and this instrument prior to energizing either unit.

Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an auto-transformer (for voltage reduction) make sure the common terminal is connected to neutral (that is, the grounded side of the mains supply).

Servicing instruction are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing unless qualified to do so.

Adjustments described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

For continued protection against fire hazard, replace the fuse(s) only with with 250V fuse(s) of the same current rating and type (for example, normal blow time, time delay, etc.). Do not use repaired fuses or short circuited fuseholders.

SAFETY SYMBOLS

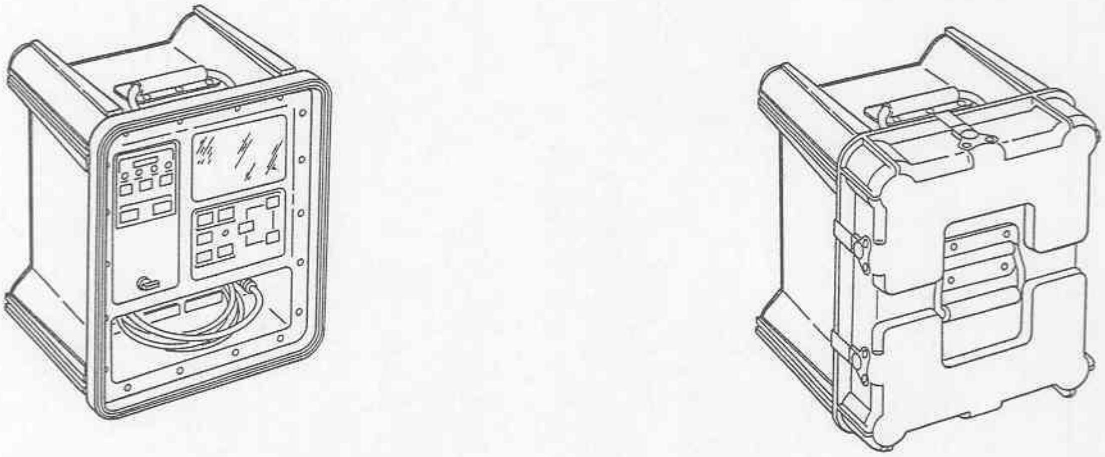
⚠ Instruction manual symbol: The individual system instruments will be marked with this symbol when it is necessary for the user to refer to the instruction manual (see Table of Contents for page references).

⚡ Indicates hazardous voltages.

⏚ Indicates earth (ground) terminal.

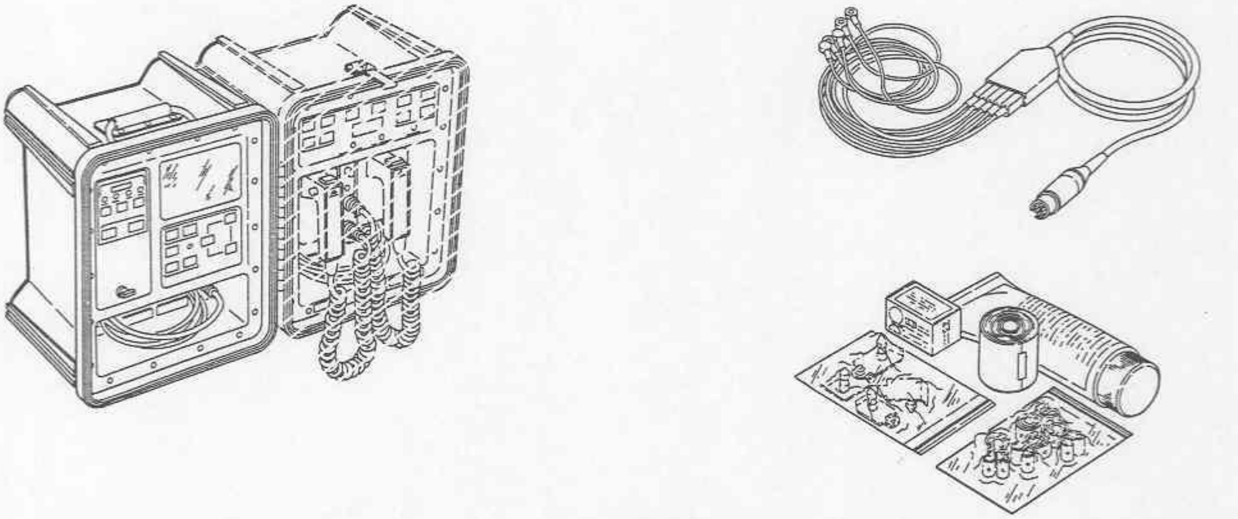
WARNING The WARNING sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION The CAUTION sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the system instruments. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.



43200M

43200MC



43200MD

ACCESSORIES SUPPLIED

Figure 1-1. HP 43200M/MC/MD Accessories Supplied

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1-1. INTRODUCTION

This Maintenance Service Manual provides the necessary maintenance instructions for the proper care and maintenance of the Hewlett-Packard model 43200M/MC/MD Monitor-Recorder module. Figure 1-1 shows an HP 43200M/MC/MD Monitor-Recorder module with all its externally supplied accessories.

The HP 43200M/MC/MD Monitor-Recorder Service Manual has seven sections:

- Section I, General Information.
- Section II, Theory.
- Section III, Checks and Adjustment.
- Section IV, Service.
- Section V, Troubleshooting.
- Section VI, Replaceable Parts.
- Section VII, Accessories and Options.

The 43110MC Defibrillator/Monitor-Recorder module Operating Guide (shipped separate) has six sections.

- Section 1, General Information.
- Section 2, Operating Controls and Indicators.
- Section 3, Emergency Defibrillation Procedures.
- Section 4, ECG Monitoring.
- Section 5, Elective Cardioversion.
- Section 6, Checkout Procedure.
- Section 7, Operator Service.
- Section 8, Operational Checks.

Additional copies of the Operating Guide or the Service Manual can be ordered separately through your nearest Hewlett-Packard office.

1-2. SPECIFICATIONS

Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) Section 1 for a complete list of specifications.

1-3. SAFETY CONSIDERATIONS

The Monitor-Recorder Module and all related documentation should be reviewed for familiarization with safety markings and instructions before operation. Refer to the Safety Considerations page found at the beginning of this manual for a summary of the safety information. Safety information for maintenance is found in appropriate places throughout this manual.

1-4. PUBLICATION CHANGE NOTICE

Publication change notices provide information necessary to update the manual. The notice is identified by the manual type and equipment model number.

1-5. DIFFERENCE IN MODELS

The HP 43200M series monitor recorder is available in three different configurations. All three configurations are functionally (electrically) the identical Monitor-Recorder module, but with different packaging as explained below.

- HP 43200M is a Monitor-Recorder module in a single case, without a front cover.
- HP 43200MC is a Monitor-Recorder module in a single case, with a front cover.
- HP 43200MD is a Monitor-Recorder module, shipped with the HP 43130M Defibrillator in a double connecting case, and designated the HP 43110MC Defibrillator/Monitor-Recorder.

Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) Section 1 for more information.

1-6. DESCRIPTION

The Monitor-Recorder module is a full-featured bedside cardiac monitor designed to offer instant access to vital patient information immediately after turn-on. Advanced design offers full automatic function to speed up rapid emergency use, with manual operator override capability provided.

One version (HP 43200MD), is designed to interconnect physically and functionally with the HP 43130M Defibrillator module for the purpose of performing synchronized cardioversion.

Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) Section 1 for more information.

1-7. ACCESSORIES SUPPLIED

The accessories supplied with the Monitor-Recorder module are shown in Figure 1-1, and listed and illustrated in Section VII.

1-8. EQUIPMENT REQUIRED BUT NOT SUPPLIED

A Defibrillator module is required for the purpose of performing synchronized cardioversion and the ability to defibrilliate the patient.

The HP 43200MD Monitor-Recorder module is designed to be used in conjunction with the HP 43130M Defibrillator Module, and when both are connected, they form the HP 43110MC Defibrillator/Monitor-Recorder system. Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) for more information.

1-9. RECOMMENDED TEST EQUIPMENT

Table 1-1 lists the test equipment recommended for testing, adjusting and servicing the Monitor-Recorder module. Essential requirements for each piece of test equipment are described in the Critical Specifications column. Other equipment can be substituted if it meets or exceeds the critical specifications.

1-10. INITIAL INSPECTION

Carefully inspect each shipping container for damage. If the shipping container or cushion material is damaged, it should be kept until the contents have been checked for completeness and the instrument has been checked for mechanical and electrical integrity.

1-11. STORAGE AND SHIPMENT

1-12. Environment

Monitor-Recorder module should be stored in a clean, dry environment. The environmental limitations for both storage and shipment are as follows:

Temperature	–30 to +65°C
Altitude	0 to 50,000 feet
Humidity	< 95% RH 40°C

1-13. Preparation for Storage

The Defibrillator module can be stored for long periods of time provided proper precautions are taken prior to and during storage. Procedures are provided below for both short term and long term storage.

Table 1-1. Recommended Test Equipment

Instrument Name	Critical Specifications	Recommended Model	Use*
DIGITAL MULTIMETER	5 to 15 Vdc ±1% measurements 0.1 to 10Ω ±2% measurements	HP 3468A	C/A/T
LOGIC PROBE	TTL/CMOS	HP 545A	T
OSCILLOSCOPE WITH PROBES	25MHz bandwidth, dual trace	HP 1740A	T
PATIENT ECG SIMULATOR	Output Level: 1 mV Range: 60 to 120 bpm normal sinus rhythm.	Dynatech Nevada ECG100	C
SAFETY ANALYZER	No substitute.	Dynatech Nevada 431F	C
SIGNAL GENERATOR	Sinewave, 1 to 5 Vp-p at 5 Hz	HP 8111A	A

* C= Checks, A=Adjustment, T=Troubleshooting

- SHORT TERM STORAGE (less than 6 months):
  1. Perform Operational Checks to verify unit is functioning. Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) Section 8 for information.
  2. Connect unit to AC power for a minimum of 24 hours with POWER key set to OFF to fully charge battery.
  3. Disconnect unit to AC power for a minimum of 24 hours. With AC power cord unplugged, verify battery voltage is >12.5 V. Refer to Perform Battery Voltage Check (Section III, paragraph A) for procedure. If battery voltage is incorrect, troubleshoot using Section V.
  4. Remove Redux® gel, paste, cream, etc.
  5. Remove thermal paper (in printer and storage compartment). Refer to HP 43110MC Defibrillator/Monitor-Recorder Operating Guide (HP part number 43201-91908) Section 7 for information. When taking paper out of printer, leave the print-head latch in the LOCKED position.
  6. Thoroughly clean unit and accessories.
- LONG TERM STORAGE (more than 6 months):
  1. Perform Short Term storage procedure listed above.
  2. Remove the Battery Assembly BT1 (Section IV, paragraph 4-3).
  3. Store Equipment and BT1 Battery Assembly separate as follows:

     Equipment can be stored (without battery) in the environmental limits as listed above indefinitely. Mark package with storage date.

     Battery should be stored at an optimum temperature of +5°C. Maintenance may have to be performed, depending on the length of time the BT1 Battery Assembly is in storage (see below). Mark package with storage date.

1-14. In Storage Maintenance

Battery Maintenance must be performed every five years (if stored at +5°C) as follows:

NOTE

If battery is stored in temperatures greater or less than +5°C, battery maintenance must be performed more often than every five years.

1. Charge battery (~14.3 Vdc float voltage) for a minimum of 24 hours.
2. Disconnect battery from charger for a minimum of 24 hours.
3. Measure battery voltage and verify reading is >12.5 Vdc.
4. Mark package with charge date and measured voltage.

1-15. Retrieval from Storage

Procedures are provided below for placing the Monitor-Recorder Module in service after both short term and long term storage.

- SHORT TERM STORAGE RETRIEVAL (stored for less than 6 months):
  1. Connect unit to AC power for a minimum of 24 hours with POWER key set to OFF to fully charge battery.
  2. Disconnect unit to AC power for a minimum of 24 hours.
  3. Perform Battery Voltage Check (Section III, paragraph A), Level II Performance Checks (Section III, paragraph B), and Safety and Maintenance Checks (Section III, paragraph C). If incorrect, adjust using Section III, and/or troubleshoot using Section V.
  4. Thoroughly clean unit.
  5. Restock accessories.
- LONG TERM STORAGE RETRIEVAL (stored for more than 6 months):
  1. Install BT1 Battery Assembly (Section IV, paragraph 4-3).
  2. Perform Short Term storage retrieval procedure listed above.

NOTE

Batteries which are being retrieved from storage may required several recharge/discharge cycles before maximum capacity is restored.

1-16. PACKAGING

Containers and materials used for original shipment of your HP 43200M/MC/MD are specifically designed for the instrument and are not readily available through Hewlett-Packard sales offices; it is recommended that you keep the packing materials for future use. If the instrument is returned to Hewlett-Packard for servicing, attach a tag indicating the product model number, serial number, return address, and a description of the problems encountered and service required. Mark the container FRAGILE to ensure careful handling. In every correspondence, refer to the instrument by product number and full serial number (e.g. HP 43130M, serial number 2400A00000).

Follow these general instructions when repackaging with commercially available materials:

- Wrap the instrument in heavy cushioning material.
- Use a strong shipping container. A double-wall carton made of 160 kilogram test material is adequate.
- Use enough shock absorbing material (3 or 4 inch layer) around all sides of the instrument to provide firm cushioning and to prevent movement inside container. Protect the control panel with cardboard.
- Seal the shipping container securely.

2-1. INTRODUCTION

This section describes the theory of operation for the 43200M/MC/MD Monitor-Recorder modules. Information is presented, starting with a brief description of the major assemblies, and progressing into greater detail, down to the circuit level. Schematic and functional block diagrams located in Section 6 are referenced when necessary.

Theory of operation is not intended as a direct troubleshooting tool; however, the level of information presented will often help the technician when troubleshooting a malfunction in the Monitor-Recorder module.

2-2. MODULE OVERVIEW (figure 2-1)

The 43200M/MC/MD Monitor Module is a multi-lead electrocardiograph, with diagnostic bandwidth capability, a high resolution CRT display, a thermal paper recorder, and a wireless interface to the 43130M Defibrillator Module. In addition, there is a digital memory which permits storage of up to 30 minutes of ECG data and status information. This process requires the interaction of many different circuits, and is briefly discussed below.

Patient ECG information is provided from two selectable sources:

- If the patient is connected to the five-lead ECG input connector on the front panel, the incoming information is sent to the ECG/Power Supply CCA where it is amplified and output to the Control CCA.
- If the patient is connected to the Defibrillator Module paddles as the ECG source, the already amplified information is received by the Infrared Link CCA and output to the Control CCA.

The ANALOG ECG information is processed by the Control CCA to calculate heart rate, determine if an alarm is violated, etc. The data generated and processed by the Control CCA is provided to the other assemblies in the Monitor-Recorder as follows:

- ECG waveform and messages are routed to the CRT Deflection Assembly for output to the CRT screen.
- ECG waveform and messages are routed to the Recorder Assembly for output to the stripchart recorder, if selected.

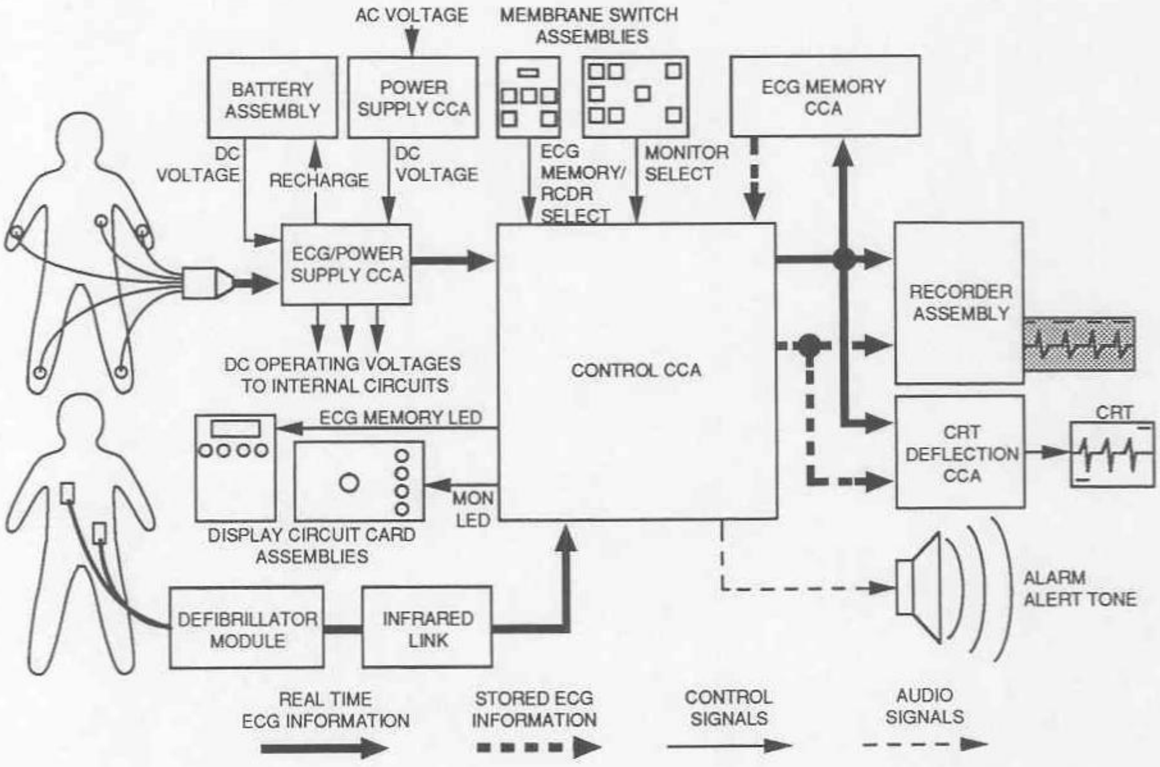

AC VOLTAGE
MEMBRANE SWITCH ASSEMBLIES
BATTERY ASSEMBLY
POWER SUPPLY CCA
ECG MEMORY CCA
DC VOLTAGE
RECHARGE
DC VOLTAGE
ECG MEMORY/ RCDR SELECT
MONITOR SELECT
ECG/POWER SUPPLY CCA
CONTROL CCA
RECORDER ASSEMBLY
DC OPERATING VOLTAGES TO INTERNAL CIRCUITS
ECG MEMORY LED
CRT
CRT DEFLECTION CCA
MON LED
DISPLAY CIRCUIT CARD ASSEMBLIES
ALARM ALERT TONE
DEFIBRILLATOR MODULE
INFRARED LINK
REAL TIME ECG INFORMATION
STORED ECG INFORMATION
CONTROL SIGNALS
AUDIO SIGNALS

Figure 2-1. 43200M/MC/MD Monitor-Recorder Module Signal Flow Functional Block Diagram.

- ECG waveform and messages are routed to the ECG Memory CCA for storage, if selected.
- Tones are generated for ECG waveform, alarm conditions, and to alert the operator of messages.

The Control CCA also monitors the status and operation of the other assemblies in the Monitor-Recorder as follows:

- Selection and response to front panel key selections.
- Read the stored ECG data from the ECG Memory CCA and send it to the CRT Deflection Assembly for output on the CRT, and/or the Recorder Assembly for a printed output, if selected.
- Operator information and equipment status to the front panel display LEDs.

DC operating voltages are provided by the ECG/Power Supply CCA using the Battery Assembly or the Power Supply CCA. Additionally, when operating on AC power, the ECG/Power Supply CCA charges the internal battery.

The Monitor-Recorder module consists of three major assemblies. Each of these major assemblies is comprised of Circuit Card Assemblies (CCA) and major circuits composed of individual parts. The three major assemblies are:

- A1 Enclosure Assembly.
- A2 Chassis Assembly.
- A3 Front Panel Assembly.

2-3. A1 ENCLOSURE ASSEMBLY

The Enclosure Assembly, consists primarily of the physical outer case and related mechanical components. Electrically it can be broken down into one assembly:

- A1A1 Infrared Link CCA.

2-4. A1A1 Infrared Link CCA (figure 6-3)

The A1A1 Infrared Link CCA provides the means of communication between the Monitor-Recorder module and the Defibrillator module. Information is exchanged between the two modules using infrared optical signals. This assembly consists of transmitter and receiver circuits that interface with the A2A2 Control CCA, over ribbon cable A1A1P36.

Transmitter Circuit

The transmitter circuit converts serial data from the microcontroller (A2A2U61) into digital infrared energy (a logic low input causes infrared energy to be transmitted). R14 protects comparator (U2A) input from potential ESD noise pulses. U2A inverts the signal and provides an open-collector drive to Q1. Q1 is a N-channel enhancement mode MOSFET providing the on/off gating of the current thru infrared emitter diode (DS3). R16, R17, and R18 provide current limiting of DS3, which sets the infrared output power of the transmitter circuit.

Receiver Circuit

The infrared receiver detects and converts infrared energy to logic level serial data, for input to A2A2U61. Infrared energy is detected by the PIN photo-diodes (DS1 and DS2), which generate a small current. This current signal is amplified and converted to a voltage signal by the two-stage amplifier constructed from transistor array (U1).

The first stage of the amplifier consists of an emitter follower (U1A), an inverting amplifier (U1B), and another emitter follower (U1C). U1A amplifies and converts the photo-current to a voltage. U1B provides inverting voltage gain. U1C provides buffering and a low impedance output to the next stage. R1 provides negative feedback to stabilize the trans-impedance of the stage. The first stage is coupled to the second stage using R5, which converts the output voltage of the first stage to a current.

The second stage consists of emitter follower (U1D), and inverting amplifier (U1E). U1D provides current gain and converts the current from the first stage to a voltage. U1E provides inversion and voltage gain.

R9 and C6 in the emitter of U1E are important for setting the dynamic range of the amplifier. They degenerate the DC gain, while preserving AC gain. This helps U1E recover quickly from saturation. R9 stabilizes the DC operating point, which allows the detection threshold to be closer to the saturation point. C2 and C5 provide compensation and increase the phase margin for stability.

Comparator (U2B) and associated resistors and capacitors are used to convert the amplifier output to a logic level signal before sending to A2A2U61. R13 provides protection from ESD noise pulses.

2-5. A2 CHASSIS ASSEMBLY

The Chassis Assembly consists of the sheet metal chassis and the components that mount on it. Electrically it can be broken down into five major assemblies:

- A2A2 Control CCA.
- A2A3 ECG/Power Supply CCA.
- A2A4 ECG Memory CCA.
- A2A5 CRT Deflection CCA.
- A2A1 Power Supply CCA.
- BT1 Battery Assembly.

2-6. A2A2 CONTROL CCA (figure 6-5)

The A2A2 Control CCA controls virtually all of the functions of the Monitor-Recorder module. The Control CCA is broken into three major circuits, each with their own CMOS (80C51 family) microprocessor, and each with a separate schematic diagram sheet.

- Main Controller circuits (figure 6-5 sheet 2).
- CRT and Display circuits (figure 6-5 sheet 3).
- Recorder circuits (figure 6-5 sheet 4).

2-7. Main Controller Circuits (figure 6-5)

Main Controller circuits are provided on sheet 2 of 4 of the A2A2 Control CCA schematic.

Internal to the A2A2 Control CCA, the Main Controller circuit monitor and send data to the other two CMOS microprocessors (U1 and U31).

External to the A2A2 Control CCA, the Main Controller circuit interprets and responds to switch closures from both the A3A1A3 and A3A3 Membrane Switch Assemblies, processes incoming analog ECG signals from the A2A3 ECG/Power Supply CCA, transmits and receives data to/from the 43130M Defibrillator Module via the A1A1 Infrared Link CCA, and generates the speaker tones. The Main Controller circuits consist of:

- Microcontroller (U61).
- Control Gate Array (U62).
- Serial Interface circuit.
- A/D Converter (U63).
- Front Panels Interface circuit.

Microcontroller (U61)

U61 (80C252) is an Intel MCS-51 type microcontroller, and is the main microcontroller of the instrument.

U61 software is interrupt driven and executes once every 4.167 ms on a cyclic basis. The software cycle is generated by an internal timer on U61, and provides the timing for the other two microcontrollers (U1 and U31) on the A2A2 Control CCA.

U61 controls the communication between U1 and U31, and the microcontroller in the Defibrillator module.

Other software functions include control of the front panels in the monitor; digital filtering of the patient ECG for display, automatic gain control, and R-wave detection; heart rate calculation and alarms; and system diagnostics.

Control Gate Array (U62)

Control Gate Array (U62) is a collection of several smaller digital circuits described below. It generates many of the system timing signals, and provides I/O expansion for U61.

System Timing Chain. Control registers and switch matrix control logic (U62), and A/D Converter (U63) are configured as memory mapped I/O to U61. U62 and U63 are both connected to the Port P0 address/data bus (U61 pins 32 to 39).

Memory Map Control Logic. Internal to U62, consists of an address latch and combinational logic to decode the address. The memory mapped devices are accessed by data memory read/write instructions from U61.

Control Registers. Three registers internal to U62 that are configured as external memory locations to U61. They are used for internal control of U62, and also as direct outputs to other parts of the system. The contents of each register are updated every 4.167 ms software cycle.

Switch Matrix Logic. Described under Front Panels Interface circuit below.

Tickle/Reset circuit. Internal to U62, provides a means of software recovery for U61. This is useful when operating in an electrically noisy environment. The circuit is a ripple counter driven by U62 system timing chain. If allowed to run freely, the counter output CONRST (U62 pin 65) will generate a signal that is 6.4 ms high and 6.4 ms low.

CONRST is connected to the power-up reset circuit (Q1, R4-R6, C2) which is then input to U61 pin 9. Under normal operation, U61 'tickles' or resets the ripple counter once each 4.167 ms software cycle. This prevents CONRST from going high and resetting U61. However, if the operation of U61 is upset by noise and fails to tickle, then CONRST will reset it within 6.4 ms. When reset, the software will start over from location 0; and tickle rapidly for 25 ms before resuming normal operation.

Tickling is accomplished by writing to one of the U62 control registers. The tickle signal from U61 is output as a test signal on U62 pin 2.

Speaker Tone. Described under Speaker circuitry below.

Serial Interface Circuit

The serial interface between all of the microcontrollers provides two states or configurations. It either allows U61 to communicate with the Recorder circuit (U1) and CRT and Display circuit (U31) microcontrollers, or allows U61 to communicate with the Defibrillator microcontroller via the A1A1 Infrared Link CCA.

A 74HC125 quad tri-state buffer (U6) is connected to form a multiplexer for the serial interface. U6 is under the control of U61, using U62 control registers. The enable signals (IR_ENABLE and SERIAL_ENABLE) are mutually exclusive, eliminating the possibility of enabling both serial interfaces at the same time.

U61 communicates with the Recorder circuit microcontroller (U1) once each 4.167 ms software cycle. Communication is in the form of a packet of three bytes. These three bytes contain ECG data and status information. U1 returns one byte of status information. If there is no response from U1 (in a given number of cycles) then U61 will apply the reset signal RECRST via U62 pin 24.

U61 communicates with the CRT and Display microcontroller (U31) once every other software cycle (8.334 ms). A data packet of four bytes is sent. It contains ECG data and status information. U31 returns a packet of three bytes, which contains playback ECG data and status information. If there is no response from U31 (in a given number of cycles) then U61 will apply the reset signal CRTRST via U62 pin 66.

U61 attempts to communicate with the Defibrillator module microcontroller via the A1A1 Infrared Link CCA, once each 4.167 ms software cycle. Once communication is established, a packet of five bytes is sent to the Defibrillator module microcontroller each software cycle. The Defibrillator module microcontroller returns a packet of four bytes. Information exchanged includes status, control, and ECG data.

A/D Converter (U63)

U63 is an 8 bit successive approximation A/D converter, with an internal 4 channel analog multiplexer, and internal clock to generate its own timing. Typical conversion times are 40 µs. U67, a +5 volt reference (1% tolerance) is used as the reference input of U63.

An A/D conversion is initiated when U61 executes an external data memory write instruction to the address that U63 occupies in the memory map. The data written to U63 is the multiplexer channel address of the signal intended for conversion. Actual conversion begins when the write signal at U63 pin 19 returns high at the end of the write instruction from U61. After the conversion is complete, the A/D interrupt signal goes low and generates an interrupt of U61. U61 reads the conversion which resets the interrupt signal at U63 pin 18. Four A/D conversions are performed each software cycle. Conversions are done on the patient ECG, battery voltage, and the supply voltages as follows:

The patient ECG signal ANALOG_ECG at P30 pin 4 from the A2A3 ECG Power Supply CCA is input to filter stage U65A. This filter stage is an inverting second order low pass filter, with a corner frequency of 95 Hz. It filters out high frequency noise and shifts the signal offset to 2.5 volts. The filter output signal at U65 pin 1 is input to U63 at pin 5 (CH3) through R89. R89, CR67, and CR68 serve as input protection for U63.

The battery voltage SWBAT is divided down by R106 and R107, and input to U63 at pin 6 (CH4). CR78 and CR79 are used as input protection for U63.

The digital +5 volt supply is divided down through R90 and R93 and applied to U63 at pin 4 (CH2). The analog supplies (+8 V and –5 V) are summed together through R91 and R92, and then input to U63 at pin 3 (CH1). CR80 and CR81 act as input protection for CH2, and CR69 and CR70 are protection for CH1.

Front Panels Interface Circuit

A switch matrix is used to read the switches on the two front panel Membrane Switch Assemblies (A3A1A3 Recorder and A3A3 Monitor). The matrix consists of 2 rows and 6 columns. The columns are pulled high by resistor network R111, and the rows are at a high logic level when not selected. Diodes are used to de-couple the rows from each other. Switch positions are determined by strobing the rows low (one row at a time) and reading the columns. A closed switch pulls the associated column low as its row is strobed low.

The switch matrix control logic is internal to U62. The row strobes are output from U62, and the columns are read into U62. Each row of switches occupies an address location in the I/O memory map. A row is selected (strobed low), when U61 executes an external data memory read instruction to the appropriate address. The matrix columns are read into U61 through U62. Switch positions are read on a periodic basis, and debounced in software.

U62 pin 3 serves a special function in the switch matrix. It is read into U61 in place of column 7 in row 2. Capacitor C70 connected to U62 pin 3 is charged through a pull-up transistor internal to U62. U61 checks the logic level of this input (which is effectively the charge on C70) to determine if the unit has recently been powered on.

The LED displays on the front panel are controlled by software in U61. The status of the LED displays is transferred serially to the front panel on signal LED*DATA*0. This data is clocked by LED CLOCK, and generated by U61. Data is clocked into serial-to-parallel registers (U10 and U11). The ECG Memory Bar Graph segments are driven by MOS to LED drivers (U12 and U13). Once the new data is clocked into U10 and U11, it is latched onto outputs by the rising edge of LED ENABLE. The LED displays are updated on a cyclic basis in software.

2-8. CRT and Display Circuits (figure 6-5)

CRT and Display circuits are provided on sheet 3 of 4 of the A2A2 Control CCA schematic.

The primary function of the CRT and Display circuit is to receive processed ECG data and status information from the Main Controller circuit and:

- Display it on the CRT (A2V1).
- Handle storage and retrieval of 30 minutes of ECG data in the A2A4 ECG Memory CCA.

Both functions are implemented with a CMOS 80C252 microprocessor (U31), a Gate Array (U33), a Digital to Analog Converter (U34), and a separate 256k RAM (A2A4 ECG Memory CCA).

CRT (A2V1) Display

Signals are generated to control the horizontal and vertical CRT deflection, the intensity of the CRT beam, and to communicate with U61.

Horizontal Deflection. HORIZ SWEEP signal has a period of 16.7 msec and controls direction of the CRT beam horizontal sweep. ECG waveforms are displayed during the beam's sweep from right to left, and messages are written on the CRT screen on the return from left to right.

Vertical Deflection. While the horizontal movement is relatively slow, the fast VERT DEFLECT signal determines discrete up-down positions of the CRT beam corresponding to the 8 bit ECG data value. A zero is bottom of screen and a 254 is top. To produce messages, the beam sweeps up and down about 0.3 inches very quickly in miniraster format.

Intensity. The three level BEAM INTENSITY signal controls the CRT brightness from off, to normal, to very bright. To produce messages, the intensity is modulated on and off quickly with the beam moving in miniraster fashion, forming the dots which make up a character. During ECG waveforms, the intensity is set to normal brightness. Should a sync marker be present (SYNC mode with Defibrillator), the intensity becomes high resulting in a bright sync marker dot on the CRT.

U61 Communication. The SER*DATA signal is a series of four serial data bytes from U61, and two serial data bytes (SERIAL RESPONSE) in return. This exchange, systematically initiated by U61, provides basis for the precise software timing of CRT signals. Two ECG data samples are received every 8.3 msec from U61. If status data is not received by U61 in four cycles, it causes U62 to reset U31.

ECG Data Handling

Two ECG data bytes are placed in a 4 second 1000 cell area of RAM reserved for CRT refresh. Only the highest or lowest byte is placed in the 30 minute 256k RAM area. Every two seconds the heart rate is also stored. Should the operator request playback of the previously stored ECG, it is obtained from RAM, and reconstructed by interpolation. Together with the heart rate collaterally stored, it is placed in the current refresh area of CRT memory, and send back to control for re-transmission to the recorder.

Microcontroller (U31) and Gate Array (U33)

The CRT and Display microcontroller (U31) is a CMOS 80C252 microprocessor. The data bus, port 0, contains multiplexed address and data. The CRT Gate Array (U33) has an address latch clocked by ALE (U31 pin 30) for the lower 8 bits of RAM address. Another U33 latch captures data for the 8 bit D/A Converter (U34). It is clocked by the MUXSEL line (U33 pin 37). Other gates in U33 will detect FF in ECG data. The SYNC intensity line (U33 pin 19) is toggled while holding the ECG data position unchanged, thus producing the bright sync marker dots.

External 256k Static RAM

Completely contained on the A2A4 ECG Memory CCA, and attached to the A2A2 Control CCA with 2 nylon standoffs and a 30 pin connector (P35). The memory contains eight 32k x 8 CMOS static RAM chips (A2A4U20 to U27), and 1 of 8 decode chip (A2A4U28). The RAM chip address lines A0 to A7 are from U33 and Port 0 of U31, and are latched by ALE (U31 pin 30). Address lines A8 to A14 are from Port 2 of U31. Chip select is performed by A15 to A17 from Port 2 of U31 (U31 pin 28), and Port 1 of U31 (U31 pins 1 and 2) thru A2A4U28.

Digital to Analog Converter (U34)

The Digital to Analog Converter (U34) and current to voltage converter (U35B), produce the Vertical signal (VERT DEFLECT) in response to signals from U31 via U33.

2-9. Recorder Circuits (figure 6-5)

Recorder circuits are provided on sheet 4 of 4 of the A2A2 Control CCA schematic.

The primary function of the Recorder circuit is to receive processed ECG data and status information from the Main Controller circuit, then send it to the recorder to be printed. Both ECG data and the appropriate annotation is printed on a 2 inch wide strip of thermal paper. This ECG data and status information could be either be input from the A2A3 ECG/Power Supply CCA, or stored data from the A2A4 ECG Memory CCA.

While the Recorder "control" circuitry resides on the A2A2 Control CCA the Recorder Assembly (A3A1) on the A3 Front Panel Assembly contains the motor, printhead and tachometers.

Printing is accomplished by pulling thermally sensitive paper across a thermal dot array printhead with a drive motor and capstan. Sensors are provided at the rear of the motor and behind the rotating paper spindle to measure both speed of the motor, and paper roll. Knowledge of paper roll speed allows the recorder microprocessor (U1) to judge conditions of low and/or no paper.

Specific Recorder circuit tasks are motor speed control, loading the printhead registers, measuring paper roll speed, and communicating with U61. These are performed with a CMOS 8051 microprocessor (U1) and several buffers.

A serial data interface allows transfer of data and status information between U1 and U61 using their dedicated serial port lines. U61 initiates the exchange every 4.167 msec with 3 data bytes, providing the primary timing signal for U1. U1 immediately returns status information. U1 is reset upon power up and again by U61 if it doesn't receive return communication within 4 consecutive cycles.

Buffers are used to protect U1 from ESD and to supply adequate drive to the printing subsystem sensors. Printhead dot information from Port 0 of U1 is latched into U2 using Port 3.6 (U1 pin 16) as the clock. The printhead is fully loaded and ready to print after 32 seven bit bytes have been loaded. PRTHD STROBE line Port 2.7 (U1 pin 28) goes low enabling the printhead drivers to turn specific dots on. The time constant of C10 and R10 ensure the printhead will turn off in case of U1 failure.

The NO PAPER RETURN line (U1 pin 26), when high, will turn on the LED in the paper roll tachometer. The NO PAPER DETECT signal (U1 pin 25) is proportional to four times the paper spindle speed. The sensor is located on the recorder housing.

The MOTOR CONTROL line (U1 pin 27) drives a FET switch that turns the motor off and on 1000 times per second. The signal is pulse width modulated to control the motor velocity. The motor uses SWBATT for power.

The MOTOR TACH line (U1 pin 12) pulses come directly from an optical detector on the motor shaft, and are proportional to 12 times the motor speed.

Speaker Circuitry

The speaker circuit generates the power-up tone, heart rate limits alarm tone, the QRS beeper tone, and the triple beep that accompanies certain operator messages. The tones are derived from U62 HRTONE (U62 pin 15), and RWTONE (U62 pin 11). HRTONE is a 1,953 Hz square wave, and RWTONE is a 1,736 Hz square wave. U61 controls which of the signals is enabled via U62 registers.

Both tones are divided by 2 (U4), and RWTONE is input to triple 2-to-1 multiplexer (U64), which is used for volume control. U64, in conjunction with R73, R74, R76 provides 8 volume settings. The output of this volume control circuit is AC coupled to summing amplifier (U7A). Volume is controlled by 3 bits of Port 1 on U61. Signal HRTONE is AC coupled to U7A thru R75, which sets the volume of this tone.

U7A drives the push-pull transistor pair (Q61 and Q62), which in turn drives the speaker (A3SP1) through C71. Resistor divider R104 and R105 provides a 2.5 volt offset to the output of U7A.

2-10. A2A3 ECG/POWER SUPPLY CCA (figure 6-6)

The A2A3 ECG/Power Supply CCA provides a selectable gain output for one of the seven possible ECG vectors (I, II, III, aVR, aVL, aVF, V), obtained from some combination of the five discrete leads as inputs. It also generates the DC power supplies for the instrument from either the BT1 Battery Assembly or the A2A1 Power Supply CCA. A charging path for the BT1 Battery Assembly is also provided when the A2A1 Power Supply CCA is connected to AC power and operating normally.

The A2A3 ECG/Power Supply CCA is broken into three major circuits, each with a separate schematic diagram sheet.

- DC-DC circuits (figure 6-6 sheet 2).
- Isolated ECG circuits (figure 6-6 sheet 3).
- Grounded ECG circuits (figure 6-6 sheet 4).

2-11. DC-DC Circuits (figure 6-6)

DC-DC circuits are provided on sheet 2 of 4 of the A2A3 ECG/Power Supply CCA schematic. All components located on sheet two of the schematic diagram have a 1xx reference designator number.

The DC-DC circuits control the generation and distribution of the various internal voltages used within the instrument, from either the BT1 Battery or the AC line connected A2A1 Power Supply CCA. The DC-DC circuits also recharge BT1 if the instrument is connected to AC power.

Normal Operation

DC-DC circuits can easily be understood by first examining the normal operating mode. Some general statements can be made which highlight the circuits operation before detailing how specific circuits operate.

With a properly working instrument and a good battery, if K102 is closed, the instrument is on. Closing K102 provides SWBATT signal, and the +8, +5, and –5 volt supplies all start up, and the instrument turns on. Relay K102 can often be heard as an audible click when the instrument is turned on or off.

Secondly, if this properly working instrument is connected to an AC source, K101 will close. When not connected to the AC line, K101 will be open.

K101 can often be heard as an audible click when the AC line is connected or disconnected.

Many of the DC-DC circuits are directly associated with controlling if K101 and K102 are opened or closed.

Controlling Relay K101

DC-DC circuits are connected to the A2A1 Power Supply CCA by three pin connector J2. When the instrument is properly connected to the AC line, the A2A1 Power Supply CCA provides +14.3 volts at about 3 amps. The third connection, POWERFAIL, is a high impedance signal which can be ignored during normal operating conditions.

The +14.3 V (VSUPPLY) biases on CR101 to about 5.11 volts. R105 and R106 divide the VSUPPLY to about 4.84 volts so that comparator (U101A) will be in its output high state, causing Q101 to turn on, and energize the coil of K101, closing the relay.

When A2A1 is not providing VSUPPLY, K101 cannot be energized. This is because VSUPPLY provides the voltage to hold K101 closed. Keeping K101 open prevents A2A1 and other components from draining the battery.

Over Voltage Protect

If for some reason the A2A1 Power Supply CCA is putting out a voltage greater then the expected +14.3 V (VSUPPLY), then the Over Voltage Protect circuit is triggered. If VSUPPLY is greater than about +15.1 V, the divided down signal generated by R105 and R106 will exceed 5.11 volts. This will force the output of U101A low, turning off Q101, and opening K101. This prevents overcharging of the battery and protects the circuits after K101.

Powerfail Mode

If the AC line voltage is too low to allow the A2A1 Power Supply CCA to provide the expected +14.3V, A2A1 will activate POWERFAIL signal. The POWERFAIL signal provides a low impedance path in parallel with CR101, shunting current away and preventing it from biasing up to the normal 5.11 V. The divided down signal generated by R105 and R106 will cause U101A to turn off Q101, and open K101.

Battery Charging LED

U101B is used to control the front panel A3A2 Monitor Control Display CCA BATT CHRG LED. When the output of U101B is low, Q102 is on, and the LED is on. When the output of U101B is high, the LED is off.

When K101 is closed, VSUPPLY is connected to the Battery Assembly (BT1) via J2 and VBATsense is nearly equal to VSUPPLY. Since R114 and R115 divide VSUPPLY to a smaller signal than R112 and R113 divide VBATsense, U101B output is low and the battery charging LED is on. Thus the LED is normally on when K101 is closed. An exception to this occurs if the thermal fuse in BT1 has opened. When the fuse is open VSUPPLY is greater than, not equal to VBATsense, and the battery charging LED will remain off even though the instrument is connected to the AC line and K101 is closed.

When the AC line is not connected, VSUPPLY is less than VBATsense, and the open collector output of U101B will not sink current without power applied to itself. The power to U101 is provided by VSUPPLY, which is unavailable. This causes the battery charging LED to be off when the AC line is not connected. R112 and R113 provide a small, but ever present drain on the battery.

Controlling Relay K102

The circuits that control K102 include Q103, programmable reference (U102), and associated components.

U102 works as follows. The signal between U102 pins 8 and 6 is the input. If the voltage at pin 8 exceeds the voltage at pin 6 by more than 2.5 volts, then the signal at pin 1 is a low impedance voltage source of 2.5 volts, capable of sinking current into pin 1. If the signal between pins 8 and 6 is less then 2.5 volts, then pin 1 is high impedance.

The normal ON/OFF function of K102 occurs as follows. When the instrument has been off for a few seconds, C103 is charged to battery voltage thru R119. Pressing the front panel ON switch pulls signal ON/OFF (connected to U102 pin 6) near ground. The charge stored on C103 holds U102 pin 8 to more than 2.5 volts above pin 6 long enough for K102 to turn on and the instrument to power up. The instrument will stay on as long as the battery voltage is greater then about +11.2 volts. This threshold is set by R119 and R120 and the hysteresis from R121. If the battery voltage drops below 11.2 volts, U102 pin 8 will not exceed pin 6 by 2.5 volts, and Q103 will turn off.

Pressing the front panel OFF switch turns off A3A2Q1, and pulls ON/OFF signal high to deactivate K102.

Internal Power Supplies.

When the instrument is on, K102 provides battery voltage (SWBAT) to the circuits used to generate the various internal power supply voltages.

Linear, three terminal, voltage regulator (U103) generates +8 volts used primarily to power the analog circuitry in the instrument. U103 has a TO92 package type.

DC to DC converter control (U104) is used to generate +5 volts to power the digital circuits. U104 contains an internal reference, controllable oscillator and high current switch, and is combined with L101, C113, and CR106 to step down SWBATT signal. R126 and R127 feedback the actual +5V signal to close the loop around U104. CR110 serves to protect circuits connected to +5V in the event of an overvoltage failure.

The switching output from U104 is used to pump charge through C110 to C111, generating a negative voltage across C111. Negative linear, three terminal, voltage regulator (U105) then provides a stable –5 volt supply used primarily to power the analog circuitry in the instrument.

2-12. Isolated ECG Circuits (figure 6-6)

Isolated ECG circuits are provided on sheet 3 of 4 of the A2A3 ECG/Power Supply CCA schematic. All components located on sheet three of the schematic diagram have a 2xx reference designator number.

Isolated ECG circuits amplifier uses five patient connected electrodes to allow the selection of seven different lead vectors, and twelve lead vectors are possible when the chest electrode is used exploratively.

ECG is a low level signal (typically 1 mV), that must be extracted from high level common mode noise signals (typically 10 V) generated by capacitive coupling of the patient to surrounding AC sources. The ECG circuit has isolated and grounded sections to protect the patient from possible hazards associated with electrical connections to the body. The isolated section circuits are electrically isolated from instrument ground. Since the patient is directly connected only to the isolated section, the patient is electrically isolated from instrument (and earth) ground.

Operation of the Isolated ECG circuit is explained by sequentially discussing the path of the ECG signal beginning at the patient and continuing until it crosses the isolation barrier into the Grounded ECG circuits (discussed below). The Isolated ECG circuit consists of:

- Protection circuits.
- Buffer Amplifier.
- Wilson Network.
- Lead Selection.
- Right Leg Drive.
- First Gain Stage.
- Chopper Modulator.
- Isolated Power Supply.

NOTE

All components described in the Protection Circuits and Buffer Amplifier will be in the Left Leg Path. Operation is identical to the similar components located in the remaining four paths.

Protection Circuits

The protection circuitry is the first that a signal from the patient encounters. The purpose of these circuits is to prevent damage to the amplifier circuits.

Neon glow bulb (DS201) will shunt energy away from the circuit if the voltage exceeds about 100 volts.

Current limiting resistors (R203 and R204), and clamp diodes (CR205 and CR206), further protect the ECG amplifier input circuitry.

Capacitor (C201) helps to remove high frequency noise from the input signal.

Resistor (R205) provides bias current to the operational amplifier.

Buffer Amplifier

The first operational amplifier (U201B) in the signal path is configured as a unity gain buffer stage. This provides a high input impedance to the patient while maintaining a low output impedance to the Wilson Network.

Wilson Network

The Wilson resistor network is the collection of resistors, R221 thru R229, which average the various input signals to allow the generation of the augmented aVR, aVL, aVF and V1 - 6 leads.

Lead Selection

Two one-of-eight analog multiplexers (U205 and U206) are used to select which lead vector (I thru V6) that the subsequent circuits will amplify. Input 1 corresponds to lead I, 2 with II, 3 with III, 4 with aVR, 5 aVL, 6 with aVF, and 7 with V1-6. The multiplexers are controlled via opto-isolators (U208 thru U210), with the control signals from the A2A2 Control CCA. U205/U206 pin 9 (S2) is connected to U208, and is the most significant bit of a three bit word which selects what input channel is connected to U205/U206 output. For example, if S2 is a logic high, S1 is a logic low, and S0 is a logic high, the word is 101 and input channel IN5 is connected to the output, U205/U206 pin 3.

First Gain Stage

The output of U205/U206 is input to the first gain stage, a differential amplifier with a gain of 9. The amplifier consists of U203A, U203B, and R232 through R234. The output of the differential amplifier is input to the Chopper Modulator circuit, and to the Right Leg Drive circuit.

R237, R238, and C207 form a low pass filter that decouples the differential amplifier from the switching transients associated with analog multiplexer (U207). C207 serves as a low impedance source to rapidly charge or discharge the transients inherent in switching U207.

Right Leg Drive

The Right Leg Drive circuit is used to minimize the effect of 60 Hz interference on the ECG. The patient is included in one of the feedback loops of the RLD amplifier (U204A), and this forces the isolated ground to track the common mode signal present on the patient. This effectively reduces the amplitude of the common mode signal seen by the First Gain Stage.

Chopper Modulator

The Chopper Modulator is a standard technique used to allow passage of the nominally low frequency ECG information across the isolation transformer. An analog multiplexer (U207) is switched at 31,250 Hz to repetitively reverse the connection between the First Gain Stage output and the isolation signal transformer (T201). This modulates the low frequency ECG signal on a 31,250 Hz carrier. The chopping technique is inversely performed on T201 output to reconstruct the low frequency ECG information in the grounded section.

The square wave signal available at the output of T202 provides the synchronous clocks required for this chopping/de-chopping process.

Isolated Power Supply

The power to operate the isolated circuits is generated by push pull converter (T202 and associated components). The center tapped primary is alternately driven from the +5V supply by Q303 and Q304 at 31,250 Hz. CR305 and CR306 protect Q303 and Q304 from transients associated with switching the inductive load. In the isolated section, the secondary windings output is full wave rectified to generate bipolar supplies of about ±6V.

NOTE

Q303, Q304, CR305 and CR306 found on sheet 4 of 4.

2-13. Grounded ECG Circuits (figure 6-6)

Grounded ECG circuits are provided on sheet 4 of 4 of the A2A3 ECG/Power Supply CCA schematic. All components located on sheet four of the schematic diagram have a 3xx reference designator number.

Grounded ECG circuits provide reconstruction, band pass filtering, and additional amplification of the ECG signal before passing it to the A2A2 Control CCA for further processing. The Grounded ECG circuit consists of:

- Switchable Bandwidth Filter.
- Second Gain Stage.
- Variable Gain Stage.

After analog multiplexer (U301) reconstructs the chopped waveform, the signal is low pass filtered by R301 and C301 to remove switching transients introduced by the chopping process.

Switchable Bandwidth Filter

The signal from the Isolated ECG circuits is passed through a switchable high pass filter. This AC coupling (C302) is required to remove DC offsets, often present due to the patient electrodes. Normally the cutoff is set to allow 0.05 Hz frequency response of the ECG amplifier. However under some circumstances it is desirable to quickly charge C302 to restore the ECG waveform to the center of the display. In this case the FAST RESTORE signal is switched high, and both Q303 and Q304 are turned on. This shorts out R304 and R305, shifting the low frequency cutoff to about 2 Hz.

Second Gain Stage

After low frequency filtering, the signal is routed to the second gain stage. This is a standard non-inverting amplifier configuration, using operational amplifier (U302) with a gain of about 60. The gain is adjustable using R311. This accuracy adjustment is used to null out gain errors anywhere in the overall signal path. The offset of this stage is also adjustable using R307, and is used to accurately center the ECG waveform on the output displays.

Variable Gain Stage

The output of the second stage is routed to the variable (third) gain stage. This gain stage combines an operational amplifier (U304) with a one-of-eight analog multiplexer (U303), and discrete resistors. It allows the choice of eight gain settings. When combined with the previous two gain stages, this provides overall ECG amplifier gain selectable at 250, 400, 650, 1000, 1300, 2000, 3000, or 4000. Logic lows at all three control inputs of U303 will select a gain of 250, all highs select a gain of 4000, etc.

The output of the variable gain stage is labelled ANALOG ECG, and is routed to the A2A2 Control CCA for subsequent filtering, level shifting, and conversion to a digital format.

2-14. A2A4 ECG MEMORY CCA (figure 6-7)

The A2A4 ECG Memory CCA is capable of storing 30 minutes of information identical in content to the information displayed on the CRT screen, along with the corresponding status information. 256 k-bytes of CMOS static RAM, under direct control of the A2A2 Control CCA CRT and Display circuit simulates a tape recorder. Since it is solid state memory, without a battery backup to maintain the stored data, all data is lost when the instrument is powered off.

Circuitry includes 8-32k X 8 CMOS static RAM ICs (U20-U27), a 1 of 8 decoder IC (U28), and appropriate de-coupling capacitors (C20-C25). The memory bus includes an 8 bit bi-directional data bus (D0-D7), a 15 bit address bus (A0-A14), two data flow control lines (~WRITE and ~READ) which control the write and read operations, and three device select lines (A15-A17). U28 generates the chip select signals (CS0n-CS7n) from the three device select lines (A15-A17) for U20 to U27.

2-15. A2A5 CRT DEFLECTION CCA (figure 6-8)

The A2A5 CRT Deflection CCA provides the drive signals and supply voltages for the Deflection Yoke Assembly (A2L1) and CRT Assembly (A2V1).

The A2A5 CRT Deflection is broken into nine major circuits.

- Power Conditioning circuit.
- Horizontal Sweep Integrator circuit.
- Horizontal Deflection Bridge circuit.
- Vertical Signal Buffer circuit.
- Vertical Deflection Bridge Amplifier circuit.
- Vertical Yoke Power Supply circuit.
- Filament Voltage Control circuit.
- High Voltage Supply circuit.
- Intensity Control circuit.

Due to the numerous circuits present, a brief overview is presented before the individual circuits are discussed.

Control signals for horizontal sweep, vertical deflection, and the beam intensity are provided by the A2A2 Control CCA CRT and Display circuit.

Horizontal Sweep

A logic level square wave (HORIZONTAL SWEEP) drives the input of the Horizontal Sweep Integrator circuit, resulting in a triangular (approximately) waveform, which is then amplified by the closed loop Horizontal Deflection Bridge Amplifier circuit. The Deflection Yoke horizontal winding is driven by this circuit, and provides the electromagnetic horizontal sweep on the CRT. Messages are written on the CRT on the left to right sweep, and the vector written ECG waveform is written on the returning right to left sweep of the CRT beam.

Vertical Deflection

Analog vertical signal (VERTICAL DEFLECTION) is amplified by the Vertical Deflection Bridge Amplifier which is similar to the horizontal circuit's amplifier. One key difference is that the DC power for the vertical yoke's driver transistors is provided by a separate Vertical Yoke Power Supply circuit.

Beam Intensity

The CRT intensity is set by a constant current Intensity Control Circuit. This circuit will set the CRT's cathode current to a specific level to maintain a uniform brightness. The Intensity Control Circuit also blanks the CRT trace as needed (e.g. when writing alphanumerics).

The High Voltage Supply circuit generates the necessary voltages for the CRT. The Filament Voltage Control circuit limits the CRT filament's current.

2-16. Power Conditioning circuit (figure 6-8)

The low current power for the Horizontal Sweep Integrator circuit and Vertical Signal Buffer circuit is filtered by C1 - L1, and C2 - L2. The high current switched battery voltage (SWBATT) and ground (DGND) for the CRT Yoke circuits and High Voltage Supply module, is provided by a separate two conductor cable (P52) which connects to J52. Bypassing for these circuits is provided by C10, C11 and C16.

The low current and high current grounds are connected together on the A2A2 Control CCA.

2-17. Horizontal Sweep Integrator circuit (figure 6-8)

The logic level square wave HORIZONTAL SWEEP is supplied by A2A2 Control CCA, and routed through R37 to provide a gain adjustment for setting the width of the CRT trace. The square wave is AC coupled into a triangular waveform generator composed of R1 to R3, C4, C5, and U2A. This circuit produces an S corrected triangular waveform which compensates for the nonlinearity in the deflection of the CRT trace near the edges. C14-R43, and C15-R44 provide filtering for U2A DC power.

2-18. Horizontal Deflection Bridge circuit (figure 6-8)

A push-pull amplifier bridge (Q1 to Q4, U1A/B) is used to generate the positive and negative drive currents for the horizontal coil in the Deflection Yoke Assembly (A2L1), which are proportional to the voltage input from the Horizontal Sweep Integrator circuit.

R4 to R7, R11, and R12 determine the gain (differential and common mode) of the amplifier. The quiescent operating point is set by the divided voltage determined by R11 to R14, with C6 providing noise immunity. Q1 and Q2 increase the current capacity of U1B's output to a level sufficient to drive the Deflection Yoke Assembly (A2L1). Q3 and Q4 provide the same function for U1A. Power for the output transistor drive circuitry is provided by switched battery (SWBATT). The current through the horizontal coil of A2L1 is sampled by R9 and R39, which are part of the amplifier's feedback circuitry. The Q of A2L1 horizontal coil is decreased by R15 for more stable performance.

2-19. Vertical Signal Buffer circuit (figure 6-8)

The analog vertical deflection signal (VERTICAL DEFLECTION) from the A2A2 Control CCA is adjusted in amplitude by R38. U2B is configured as a unity gain buffer amplifier. This provides a low impedance signal source for driving the Vertical Deflection Bridge Amplifier circuit.

2-20. Vertical Deflection Bridge Amplifier circuit (figure 6-8)

Circuit operation is similar (analog version) to the Horizontal Deflection Bridge Amplifier circuit described above. A push-pull amplifier bridge (Q5 to Q8, U1C/D) is used to generate the positive and negative drive currents for the vertical coil in the Deflection Yoke Assembly (A2L1).

R16 to R19, R23, and 24 determine the gain (differential and common mode) of the amplifier. The quiescent operating point is set by the divided voltage determined by R8 and R10, with C9 providing noise immunity. Due to the higher current requirements for driving the vertical coil of A2L1, Darlington transistors (Q5 to Q8) are used in the amplifier bridge circuit. Q5 and Q6 increase the current capacity of U1C's output to a level sufficient to drive A2L1 vertical coil. Q7 and Q8 provide the same function for U1D. CR3 and CR4 help to reduce the crossover distortion by lessening the output swing at U1C/D output during zero crossover. Power for the output transistor drive circuitry is provided by the Vertical Yoke Power Supply circuit.

During the alphanumeric writing portion of the CRT trace (left to right sweep) the bridge amplifier is supplied with 12 Vdc power, but during the ECG writing portion of the CRT trace (right to left sweep) the output amplifier is supplied with 24 Vdc. The higher supply voltage (for the ECG vector scan) provides sufficient drive capability for A2L1 vertical coil inductance to accurately draw the ECG waveform with its steep vertical spikes at each QRS wave. The current through A2L1 vertical coil is sampled by resistor R21, which is part of the amplifier's feedback circuitry. The Q of A2L1 vertical coil is decreased by a R25 for more stable performance.

2-21. Vertical Yoke Power Supply circuit (figure 6-8)

The Vertical Deflection Bridge Amplifier circuit requires 12 and 24 Vdc power to properly drive A2L1. The Vertical Yoke Power Supply (CR6, CR7, Q11 to Q13) is basically a voltage doubler with only a single diode and capacitor (output is not maintained at the doubled voltage). The horizontal sweep signal HORIZONTAL SWEEP is a logic level square wave with a period of 16 msec. Q11 is alternately turned off/on by this square wave. When Q11 is conducting, base current from Q13 through R35 turns Q13 on. Alternatively, when Q11 is not conducting, R34 pulls the drain to near 12V, which causes Q13 to turn off while causing Q12 to conduct. R36 limits the maximum current through Q12. The result is that the collector of Q13 switches between nearly zero volts and nearly 12 V. C13 is charged to 12 V through CR7 when the collector of Q13 is at near ground potential. When Q13 switches, the cathode of CR7 is raised to nearly 24 V since the C13 has a 12 V charge across itself. The value of C13 is chosen to insure that the voltage drop during the 24 V cycle is acceptably small.

2-22. Filament Voltage Control circuit (figure 6-8)

The CRT (A2V1) filament is powered by the 12 Vdc battery voltage SWBATT. R32 and R33 limit the DC current to A2V1 filament, insuring long tube life. SW BATT will exceed 12 V by about 2.3 V during AC operation and battery charging.

2-23. High Voltage Supply circuit (figure 6-8)

The sealed power supply module with support board, generates the anode, grid, and cathode voltages for the CRT (A2V1).

> Anode voltage is +5.5 kV, and high voltage connector (P51) connects directly to A2V1 anode.
>
> Grid 2 and 4 of A2V1 are biased at +100 V relative to ground. This power supply line is bypassed by C12.
>
> +40 V is provided for use by the Intensity Control circuit.

Grid 1 and CRT DAG connect to ground. The frame around the CRT faceplate connects to the DAG by a copper shorting strap. The metal frame to which the CRT mounts is connected to ground via a wire on J53 pin 7.

2-24. Intensity Control circuit (figure 6-8)

The intensity of the CRT trace is controlled by modulating the cathode current. Two distinct current levels are used to provide two brightness levels for normal ECG and the ECG sync marker (higher intensity). The INTENSITY control is connected to the emitter of the common base circuit made up of Q9 and Q10. Thus different impedances as seen from the emitter (as controlled by A2A2 Control CCA) cause different cathode current levels. To minimize induced noise on the intensity signal (i.e. on the ribbon cable P31), a current 40 times larger then the beam current is sent over the ribbon cable. A current divider is used (R26, R27, Q9, Q10) to divide the intensity signal by 40. The first transistor (Q9) controls the cathode current. The second transistor (Q10) provides some thermal compensation for the current divider and provides the CRT blanking feature. The blanking circuit is comprised of R29 and CR5. When the CRT trace is to be blanked, the intensity control is pulled high (+5V). Both Q9 and Q10 will be turned off and the collector of Q9 will go high. CR5 will be forward biased while the cathode capacitance is charged by R29. A neon lamp (DS1) and R31 protect the intensity circuit from CRT arcing.

2-25. A2A1 POWER SUPPLY CCA (figure 6-1)

The A2A1 Power Supply Assembly is capable of converting a 47 to 63 Hz AC input, between 103 and 253 volts, to a low ripple +14.3 volt DC output, with a maximum short circuit current of approximately 4 A, and an output power limit of 40 watts. The supply is a high efficiency switching type, with an operating frequency of about 100 kHz. It is used as the primary power source for the instrument whenever acceptable AC power is available, with or without a battery installed.

If the AC line voltage is too low to allow A2A1 to provide the expected +14.3 V, a POWERFAIL signal is activated. The POWERFAIL signal is used by the DC-DC circuits on the A2A3 ECG/Power Supply CCA to open A2A3K101 and isolate A2A1.

The A2A1 Power Supply CCA is not repairable and contains no replaceable parts.

2-26. BT1 BATTERY ASSEMBLY (figure 6-1)

The Battery Assembly consists of a sealed, six cell lead acid type battery with a storage capacity of 2.9 Amp-hours at 12 volts (nominal). With a full charge, the battery is capable of providing a minimum of 4 hours without using the recorder, and a minimum of 1 hour if the recorder is used continuously.

There are three wires (P14) exiting the battery assembly. Two are connected to the positive, and one is connected to the negative side of the battery. A nonrecoverable thermal fuse is in series with one of the positive wires. It is designed to disconnect the battery from the charging circuit at a still safe, through high, temperature. The other positive wire is only used to sense battery voltage and does not carry large current.

The battery assembly has a hose fitting which vents through a flexible tube to the front panel. In the event of a malfunction, where hydrogen is generated within the cells, the tube vents the hydrogen out of the enclosure.

2-27. A3 FRONT PANEL ASSEMBLY

The A3 Front Panel Assembly consists of the plastic front panel, and the components that mount to it. Electrically it can be broken down into five major assemblies/circuits.

- A3A1 Recorder Assembly.
- A3A2 Monitor Control Display CCA.
- A3A3 Monitor Control Membrane Switch Assembly.
- Speaker (SP1).
- Power Cord (P19).

2-28. A3A1 RECORDER ASSEMBLY (figure 6-1)

The A3A1 Recorder Assembly is has a full 0.05 to 100 Hz diagnostic bandwidth printing capability for ECG data. Although mechanically attached to the A3 Front Panel Assembly, it is electrically connected and controlled by the A2A2 Control CCA using a 40 conductor ribbon cable (P4). Approximately half of the lines in P4 are used directly by the thermal recorder circuits.

Mechanically, the A3A1 Recorder Assembly contains the motor assembly, spindle assembly, paper housing assembly, and thermal array printhead to output information sent from the A2A2 Control CCA, on a 2 inch wide roll of thermal paper.

Electrically, the A3A1 Recorder Assembly can be broken down into three major assemblies.

- A3A1A1 Recorder Display CCA.
- A3A1A2 Recorder Interface CCA.
- A3A1A3 Recorder Membrane Switch Assembly.

2-29. A3A1A1 RECORDER DISPLAY CCA (figure 6-11)

The A3A1A1 Recorder Display CCA is a printed circuit assembly consisting of a 10 segment bar graph (DS5), and four individual LEDs (DS1 to DS4).

Each segment of the bar graph (DS5) has a dedicated signal line for the cathode, and the anodes are connected to +5 Vdc via a series current limiting resistors (R1 to R10). The segments are enabled by pulling the cathode line to logic '0' (ground).

Each of the four LEDs (DS1 to DS4) has a dedicated signal line for the cathode, and the anodes are connected to +5 Vdc via a series current limiting resistors (R11 to R14). The LEDs are enabled by pulling the cathode line to logic '0' (ground).

DS1 to DS5 are connected directly to independent circuits on connector (P41A/B).

2-30. A3A1A2 RECORDER INTERFACE CCA (figure 6-12)

The A3A1A2 Recorder Interface CCA interconnects the A2A2 Control CCA to the following circuits:

- Recorder Printhead.
- Motor and Related Sensors.
- A3A1A3 Recorder Display CCA.
- A3A1A3 Recorder Membrane Switch Assembly.

All control signals to and from the A2A2 Control CCA are provided on P4 (40 conductor ribbon cable).

The high current +12 Vdc from the A2A3 ECG/Power Supply CCA for the recorder motor and thermal printhead is provided on P45 (2 conductor cable).

The connections for the thermal printhead (J43), A3A1A3 Recorder Display CCA (J41) and A3A1A3 Recorder Membrane Switch Assembly (J42) connect directly to P4.

LED (CR3) and photo-transistor (Q2) are used to sense the speed of the recorder's motor. A shutter (attached to the rear motor shaft) causes Q2 to turn off/on. R6 and R3 provide the necessary current limiting to CR3 and Q2. The signal is sent back to A2A2 Control CCA on P4 pin 36.

The recorder motor is controlled by Q1. An AC signal (P4, pin 39) is sent to control the gate of Q1 (via C2, R4, R5, and CR2). CR1 conducts the back EMF from the motor winding. The motor connects to J44 pins 3 and 4.

An additional LED and photo-transistor pair is mounted on the recorder frame to sense the motion of the ECG paper roll spindle (J44, pin 1-2, 5-6). R1 ands R2 provide the required current limiting for the photo sensor components. The signals are routed back to A2A2 Control CCA on P4 pin 38.

2-31. A3A1A3 RECORDER MEMBRANE SWITCH ASSEMBLY (figure 6-1)

The A3A1A3 Recorder Membrane Switch Assembly is a combination label and switch circuit that mounts into the recorder door.

5 normally open switches are provided (MODE, RIGHT/LEFT arrow, 1 mV CAL, and RUN/STOP) to control recorder/memory operations. The switches are a domed membrane type with screened conductive surfaces. Depressing a switch will cause <250Ω of resistance between the specified terminals:

Key Switch	P42 pin number
RUN/STOP	1-2
1 mV CAL	9-8
MODE	1-3
LEFT ARROW	9-7
RIGHT ARROW	4-5
Open (no connection)	6

RUN/STOP and 1 mV CAL are used to control the recorder mechanical assembly via the A2A2 Control CCA. MODE, RIGHT and LEFT arrow are used to control the A2A4 ECG Memory CCA via the A2A2 Control CCA.

NOTE

For more information about how switch presses are detected, refer to A2A2 Control CCA theory.

2-32. A3A2 MONITOR CONTROL DISPLAY CCA (figure 6-13)

The A3A2 Monitor Control Display CCA is a printed circuit assembly consisting of four circuits.

- Power on/off circuit.
- Battery Charge LED circuit.
- Select/Alarm/Low Battery LED circuit.
- Switch Panel Diode circuit.

Power on/off Circuit

When the unit is not powered up, Q1 is not conducting and the +5 V is not present. To turn the unit on, one side of R7 (P10 pin 3) is switched to ground when the ON key is depressed. Once the ON/OFF signal is pulled low (P33 pin 14), the monitor will begin to power up. Once powered, the power supply will generate +5 V which is applied to the gate of Q1 (via R4 and R5), causing Q1 to remain conducting after R7 is no longer connected to ground using the ON switch. To turn the unit off, one side of R6 (P10 pin 5) is switched to ground when the front panel OFF key is depressed. This causes the gate of Q1 to drop to near 0 volts, causing Q1 to stop conducting. The +5 V supply is disabled once the unit is powered down. C3, CR13, and CR14 provide noise and static protection.

Battery Charge LED Circuit

DS6 is enabled when a +5V signal is applied to P33 pin 13. R16 limits DS6 current.

Select/Alarm/Low Battery LED Circuit

DS1 to DS5, and DS7 are controlled by 8 bit serial to parallel shift register (U1). Each time the LED display information SER DATA (P33 pin 6) is to be updated, serial data is shifted into U1 data input (SER). The shift register clock SCK (P33 pin 8) is positive edge triggered. Once the new LED data is loaded into U1, the data register clock LED ENABLE (P33 pin 7) is toggled to load the data into U1. The output enable (G) on U1 is held low to always enable the output drivers. The shift register clear SCLR is held high to disable this function. The LEDs (DS1 to DS5, and DS7) have series current limiting resistors (R10 to R15) which connect to +5V. R1 to R3 and CR1 to CR6 provide static protection for U1.

Switch Panel Diode Circuit

CR7 to CR9 and CR10 to CR12 connect to the A3A3 Monitor Control Membrane Switch Assembly using P10. They are used to allow the switch panel to be operated in a matrix format.

2-33. A3A3 MONITOR CONTROL MEMBRANE SWITCH ASSEMBLY (figure 6-1)

The A3A3 Monitor Control Membrane Switch Assembly is a combination label and switch circuit that mounts into the front panel of the Monitor-Recorder module.

8 normally open switches are provided (ON, OFF, ALARMS ON/OFF, LEAD SELECT, PADDLES, SELECT, DOWN and UP arrow) to control Monitor-Recorder operations. The switches are a domed membrane type with screened conductive surfaces. Depressing a switch will cause <250Ω of resistance between the specified terminals:

Key Switch	P10 pin number
ON	4 - 3
OFF/RECHARGE	4 - 5
ALARMS ON/OFF	11 - 1
LEAD SELECT	6 - 2
PADDLES	9 - 8
SELECT	6 - 7
DOWN ARROW	11 - 12
UP ARROW	9 - 10

NOTE

For more information about how switch presses are detected, refer to A2A2 Control CCA theory.

2-34. A3SP1 Speaker (figure 6-1)

The A3SP1 Speaker (beeper) is used to audibly signal the user of various conditions. The 8Ω speaker is physically mounted on the front panel. It outputs an audible tone to alert the operator. The drive signal for the beeper is connected to the drive signal from A2A2 via P37.

2-35. A3P19 AC Line Cord (figure 6-1)

Standard three wire hospital grade cable is connected within the instrument directly to A2A1.

3-1. INTRODUCTION

This section describes the Checks and Adjustments that may need to be performed from time to time, or after a major repair. Checks and Adjustments are provided in four parts.

A. INSTRUMENT MODES

B. LEVEL II PERFORMANCE CHECKS

C. SAFETY AND MAINTENANCE CHECKS

D. ADJUSTMENTS

A. INSTRUMENT MODES

3-2. READ BATTERY VOLTAGE

Battery voltage should be checked weekly as follows:

1. Disconnect the AC power cord.
2. Press the POWER ON key.
3. Press the SELECT key until the BEEPER indicator is on.
4. Press and hold both the UP and DOWN arrow keys at the same time. Verify the CRT screen displays reads "BATT ~13.0V".

NOTE

Low Battery warning message comes on at ~11.8 V, and low battery shutdown occurs at ~11.2 V.

5. Reconnect the AC power cord, repeat steps 1-4, and verify the CRT screen display reads "BATT ~14.3V".

NOTE

~14.3 V indicates the battery charger is working normally.

B. LEVEL II PERFORMANCE CHECKS

Perform these checks every six months. For best results, use the equipment recommended. Record the Monitor-Recorder serial number and the date the checks were performed.

3-3. TEST EQUIPMENT

Test equipment required for performing the level II performance, and safety and maintenance checks is listed in Table 3-1. Test equipment characteristics and a recommended commercial model are included. If the recommended model is not available, select another with similar characteristics and capabilities.

WARNING

LETHAL VOLTAGES ARE PRESENT INSIDE THE MONITOR-RECORDER MODULE AND ARE EXPOSED WHEN THE MONITOR-RECORDER IS REMOVED FROM THE CASE. DO NOT WORK INSIDE THE INSTRUMENT WHEN POWER IS APPLIED.

Table 3-1. Required Test Equipment for Performance, Safety and Maintenance Tests

REQUIRED TEST EQUIPMENT FOR LEVEL II PERFORMANCE, SAFETY and MAINTENANCE TESTS

REQUIREMENT	NECESSARY QUALIFICATIONS
DIGITAL VOLTMETER Recommend: HP 3468A	Capable of 5 to 15 Vdc ±1% measurements.
OHMMETER	Capable of 0.1 to 10Ω ±2% measurements.
PATIENT ECG SIMULATOR Recommend: Dynatech Nevada ECG 100	Output Level: 1 mV, 60 to 120 bpm normal sinus rhythm.
SAFETY ANALYZER Recommend: Dynatech Nevada 431F	No substitute.
SIGNAL GENERATOR Recommend: HP 8111A	Sinewave, 1 to 5 Vp-p at 5 Hz

3-4. ECG AMPLIFIER NOISE

1. Connect the Equipment as shown in Figure 3-1.

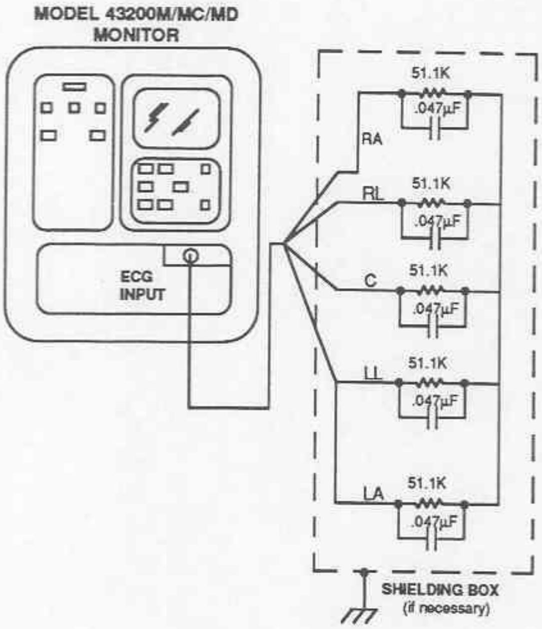


Figure 3-1. ECG Amplifier Noise Test Setup.

2. Press the POWER ON key.
3. Press LEAD SELECT key until lead II is displayed.
4. Press SELECT key until ECG SIZE indicator is on.
5. Press UP arrow key ten times.

NOTE

This sets the internal GAIN to maximum.

6. Press RUN/STOP key and allow a 5 second recorder strip run. Press RUN/STOP key again to stop run.
7. Verify ECG p-p noise as shown on the recorder strip is less than 1/16".

NOTE

Test limit is 30 µV p-p referred to input. Each vertical pixel/dot on the recorder strip or CRT screen represents 5µV referred to input with the ECG gain set to maximum (40 mm/mV).

8. Press POWER OFF/RECHARGE key and disconnect test equipment.

3-5. ECG AMPLIFIER GAIN

1. Connect the Equipment as shown in Figure 3-2.

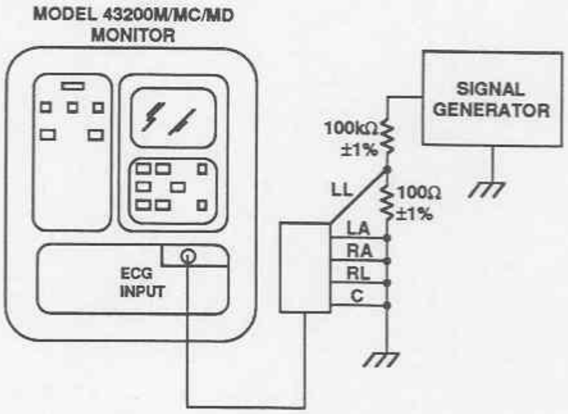


Figure 3-2. ECG Amplifier Gain Test Setup.

2. Press the POWER ON key.
3. Press LEAD SELECT key until lead II is displayed.
4. Press SELECT key until ECG SIZE indicator is on.
5. Press DOWN arrow key ten times. Press UP arrow key three times.

NOTE

This sets the internal GAIN to 1000. Press RECORDER RUN and verify gain is set to 10 mm/mV. Press RECORDER STOP.

6. Adjust Signal Generator output to 2.0 Vp-p at 5 Hz sinewave.
7. Press RUN/STOP key and allow a 5 second recorder strip run. Press RUN/STOP key again to stop run.
8. Verify ECG signal as shown on the recorder strip is 20 mm p-p ±5%.
   - If reading is incorrect, perform ECG Gain Adjust (paragraph 3-10).
   - If reading is correct, proceed with step 9.

9. Press SELECT key until ECG SIZE indicator is on.
10. Press DOWN arrow key ten times.

NOTE

This sets the internal GAIN to 250 (minimum).

11. Adjust Signal Generator output to 5.0 Vp-p.
12. Press RUN/STOP key and allow a 5 second recorder strip run while observing the CRT screen. Press RUN/STOP key again to stop run.
13. Verify ECG signal as shown on the CRT Screen is 16 mm p-p ±10%, and as shown on the recorder strip is 12.5 mm p-p ±10%.
14. Press SELECT key until ECG SIZE indicator is on.
15. Press UP arrow key one time.

NOTE

Each time the UP arrow is pressed, the internal GAIN is increased by one step (i.e., from 250 to 400, then to 650, etc).

16. Adjust Signal Generator output to the appropriate levels shown in Table 3-2.
17. Repeat steps 12 to 16 using Table 3-2, and verify readings on the CRT screen and recorder strip are within specified limits.

Table 3-2. ECG Amplifier Gain Limits.

Sig Gen p-p Input Voltage	Theoretical Gain	Measured Height (mm p-p) ±10%	
		CRT	Recorder
5	0250	16	12.5
5	0400	26	20.0
5	0650	43	32.5
2	1000	26	20.0
2	1300	34	26.0
1	2000	26	20.0
1	3000	40	30.0
1	4000	53	40.0

18. Press POWER OFF key and disconnect test equipment.

C. SAFETY AND MAINTENANCE CHECKS

Perform these checks every six months or after a major repair.

NOTE

Make these initial checks before performing the safety tests.

3-6. POWER CORD TO CHASSIS GROUND RESISTANCE CHECK

1. Press the POWER OFF key and disconnect the AC power cord. Connect the test equipment as shown in Figure 3-3.

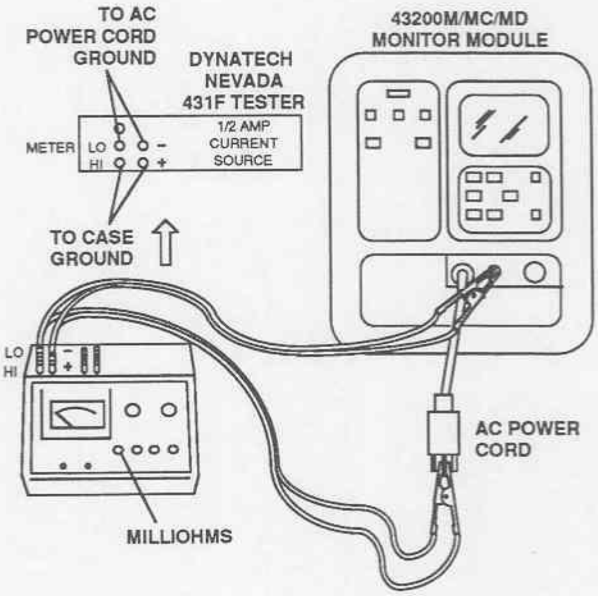
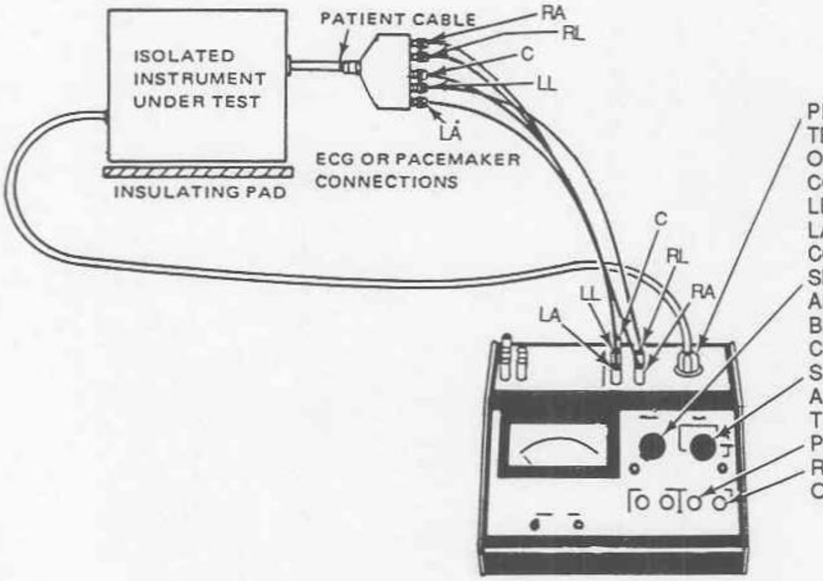


Figure 3-3. Power Cord to Chassis Ground Resistance Check Test Setup.

2. Connect the dual banana plug of a Kelvin Cable between the LO meter terminal of the Tester and the – (negative) terminal of the 1/2 amp source on the Tester.
3. Connect the clip on the other end of the Cable to the ground pin of the Monitor-Recorder module male power connector.


PATIENT CABLE
RA
RL
C
LL
LA
ISOLATED INSTRUMENT UNDER TEST
INSULATING PAD
ECG OR PACEMAKER CONNECTIONS
C
RL
RA
LL
LA

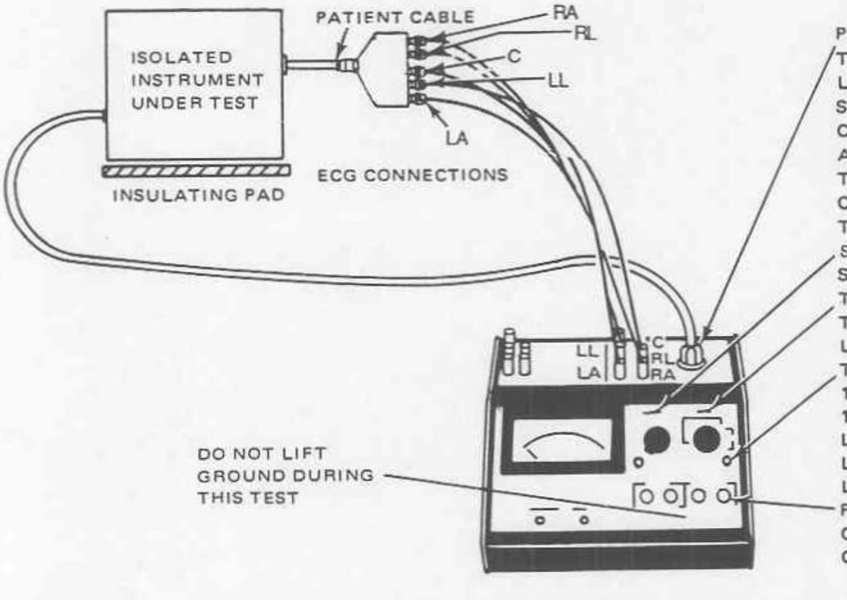
PLUG THE INSTRUMENT INTO THE TEST RECEPTACLE LOCATED ON TOP OF THE SAFETY ANALYZER. THEN CONNECT THE INSTRUMENT'S ECG LEADS TO THE APPROPRIATELY LABELED (LA, RL, RA, LL, C) CONNECTORS.

SET FUNCTION SWITCH TO CURRENT.

AFTER THESE CONNECTIONS HAVE BEEN MADE, THE TEST IS CONDUCTED BY ADVANCING THE SELECTOR SWITCH THROUGH THE APPLICABLE POSITIONS OF THE TEST III PORTION OF THE SWITCH.

PRESS THE LIFT GROUND AND/OR REVERSE POLARITY BUTTONS TO OBTAIN DESIRED TEST CONDITIONS.

Figure 3-4. Patient Lead Leakage Current (Source Leakage) Test Setup.


PATIENT CABLE
RA
RL
C
LL
LA
ISOLATED INSTRUMENT UNDER TEST
INSULATING PAD
ECG CONNECTIONS
LL
LA
C
RL
RA

DO NOT LIFT GROUND DURING THIS TEST

PLUG THE INSTRUMENT INTO THE TEST RECEPTACLE LOCATED ON TOP OF THE SAFETY ANALYZER. THEN CONNECT THE INPUTS OF THE APPLICABLE TEST ADAPTER TO THE LL, LA, RA, RL, AND C CONNECTORS ON THE TOP OF THE SAFETY ANALYZER.

SET FUNCTION, SWITCH TO CURRENT. TURN THE SELECTOR SWITCH TO TEST V TO COMBINE THE LEADS PROVIDED BY THE TEST ADAPTER. PRESS THE 115V RED BUTTON TO APPLY 115V TO THE COMBINED LEADS. FOR 115V APPLIED, LEAKAGE CURRENT TEST LIMIT IS 10.0 MICROAMPERES.

PRESS REVERSE POLARITY TO OBTAIN DESIRED TEST CONDITION.

Figure 3-5. Patient Lead Leakage Current (Sink Current) with 115V Applied Test Setup.

4. Connect the dual banana plug of the second Kelvin Cable between HI terminal of the meter section and the + (positive) terminal of the 1/2 amp source.
5. Connect the clip on the other end to a banana/banana cable inserted in the external ground jack on the front of the Monitor-Recorder module.
6. Press MILLIOHMS and read the resistance on the current ranges. Verify the readings is less than or equal to 0.20Ω.
7. Disconnect test equipment.

3-7. PATIENT LEAD LEAKAGE CURRENT (SOURCE LEAKAGE) TO GROUND

1. Connect the test equipment as shown in Figure 3-4.

NOTE

Follow any instructions included in the figure.

2. Perform the test as instructed in figure 3-4.
3. Using the patient cable in the test setup, measure leakage current between each patient lead and ground. Verify current is not more than 10 μA.
4. Repeat steps 2 and 3 under each of the following power polarity and grounding conditions with the power ON and OFF.

CONDITIONS:

a. Chassis grounded, standard power polarity.
b. Chassis grounded, reverse power polarity.
c. Chassis ungrounded, standard power polarity.
d. Chassis ungrounded, reverse power polarity.

5. Press POWER OFF key and disconnect test equipment.

3-8. LEAKAGE CURRENT BETWEEN PATIENT LEADS CHECK

1. Connect the test equipment as shown in Figure 3-4.

NOTE

Follow any instructions included in the figure.

2. Perform the test as instructed in figure 3-4.
3. Using the patient cable in the test setup, measure the leakage current between each patient lead. Verify current is not more than 10 μA.
4. Repeat steps 2 and 3 under each of the following power polarity and grounding conditions with the power ON and OFF.

CONDITIONS:

a. Chassis grounded, standard power polarity.
b. Chassis grounded, reverse power polarity.
c. Chassis ungrounded, standard power polarity.
d. Chassis ungrounded, reverse power polarity.

5. Press POWER OFF key and disconnect test equipment.

3-9. PATIENT LEAD LEAKAGE CURRENT (SINK CURRENT) WITH 115 VOLTS APPLIED

1. Connect the test equipment as shown in Figure 3-5.

NOTE

Follow any instructions included in the figure.

2. Perform the test as instructed in figure 3-5.
3. Using the exact test setup shown, measure the patient lead leakage current for all leads tied together while driving the leads with line voltage. Verify current is not more than 10μA.
4. Repeat steps 2 and 3 under each of the following power polarity conditions with chassis grounded and with the power ON and OFF.

CONDITIONS:

a. Chassis grounded, standard power polarity.

b. Chassis grounded, reverse power polarity.

5. Press POWER OFF key and disconnect test equipment.

D. ADJUSTMENTS

Internal adjustments are made at the factory and normally do not require attention. However, if assemblies are repaired or replaced, check and adjust as necessary.

The printhead should be cleaned every 3 months (paragraph 3-15), or when a buildup of carbon residue becomes excessive and causes poor print quality.

All test equipment necessary to make the adjustments is listed in each Adjustment Procedure.

The instrument case must be opened to gain access to the adjustment controls. Refer to Section IV as required.

3-10. ECG GAIN ADJUSTMENT

This is for adjustment of the ECG Gain Amplifier. Adjustment location is on the A2A3 ECG/Power Supply CCA (figure 6-6).

Equipment Required:

Signal Generator	Capable of 3 Vp-p at 5 Hz ±2% sinewave.
Fixed Resistors	(1) 100kΩ and (1) 100Ω, ±1%.

Procedure:

1. On the Monitor-Recorder Module:
   - Press the POWER OFF key.
   - Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a ramp waveform followed by a stair step waveform.
   - Verify BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "GAIN xxxx a" is displayed on the CRT screen.
2. Press SELECT key until ECG SIZE indicator is on. Press the UP or DOWN arrow keys until "GAIN 1000" is displayed on the CRT screen.
3. Press SELECT key until BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "NOISE x.xxv" is displayed on the CRT screen.
4. Connect the Signal Generator and resistors as shown in figure 3-6.

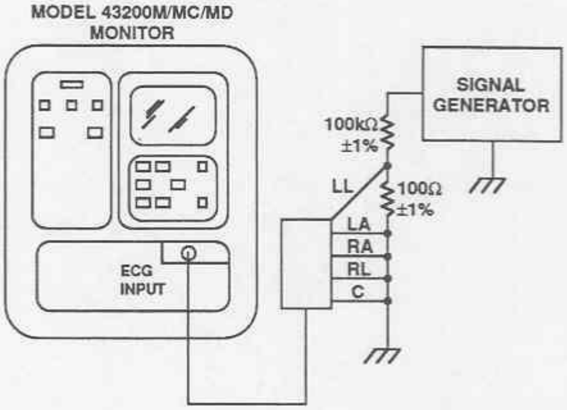


Figure 3-6. ECG Gain Adjust Test Setup.

5. Adjust Signal Generator output to 3.0 Vp-p at 5Hz sinewave.
6. Press LEAD SELECT key until lead II is displayed on CRT screen.
7. Adjust A2A3R311 "GAIN" until CRT screen reads NOISE 3.00v (2.90 to 3.10).
8. Press POWER OFF key and disconnect test equipment.

3-11. ECG OFFSET ADJUSTMENT

This is for offset adjustment of the ECG Gain Amplifier. Adjustment location is on the A2A3 ECG/Power Supply CCA (figure 6-6).

Equipment Required:

Shorting Jumpers (5)

Procedure:

1. On the Monitor-Recorder Module:
   - Press the POWER OFF key.

- Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a ramp waveform followed by a stair step waveform.
- Verify BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "GAIN xxxx a" is displayed on the CRT screen.

2. Press SELECT key until ECG SIZE indicator is on. Press the UP or DOWN arrow keys until "GAIN 4000" is displayed on the CRT screen.
3. Press SELECT key until BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "OFFST x.xxv" is displayed on the CRT screen.
4. Using the jumpers, short all five patient leads together. Press LEAD SELECT key until lead II is displayed.
5. Press RUN/STOP key and allow a recorder to run.
6. With a flat baseline ECG, adjust A2A3R308 "OFFSET" until CRT screen reads OFFST 0.00v (<0.50), and trace is centered on both CRT screen and recorder strip.
7. Press RUN/STOP key again to stop recorder run.
8. Press POWER OFF key and disconnect test equipment.

3-12. CRT DISPLAY ADJUSTMENTS

The CRT display adjustments include the CRT beam centering, and the horizontal and vertical size adjustments. Adjustment location is on the A2A5 CRT Deflection CCA (figure 6-8), and A2L1 Deflection Yoke Assembly (back of CRT).

Equipment Required:

Ruler	Must measure in mm to 61 mm.

Procedure:

1. If Defibrillator Module is connected, press its POWER OFF key.
2. On the Monitor-Recorder Module, press the POWER OFF key, then press POWER ON key.
3. Adjust the ring magnet tabs on the CRT Yoke (A2L1) to center image on the CRT screen, if necessary.
4. Adjust the A2A5R38 ("V") until the distance from the top of the "P" to the bottom of the "NO DEFIB" message on the CRT screen is 60 mm, ±1 mm.
5. Press LEAD SELECT key until lead III is displayed on the CRT screen.
6. Adjust A2A5R37 ("H") until the "III" is just on the screen, and the ends of the ECG trace are readily visible.

3-13. HIGH VOLTAGE ADJUSTMENTS

There are no field adjustments for the High Voltage Module on the A2A5 CRT Deflection CCA.

3-14. POWER SUPPLY ADJUSTMENT

There are no field adjustments for the A2A1 Power Supply CCA.

3-15. CLEANING THE RECORDER PRINTHEAD

The printhead should be cleaned every 3 months, or when a buildup of carbon residue becomes excessive and causes poor print quality.

1. Open the Recorder Door and place in the fully open position. Place the printhead latch (right side) in the LOCK position. Verify the printhead is raised off the pressure roller (left side).
2. Dampen a cotton swab in alcohol and wipe the area of the printhead just above the roller until all the carbon residue has been removed.
3. Feed the paper between the printhead and pressure roller and UNLOCK the printhead latch.

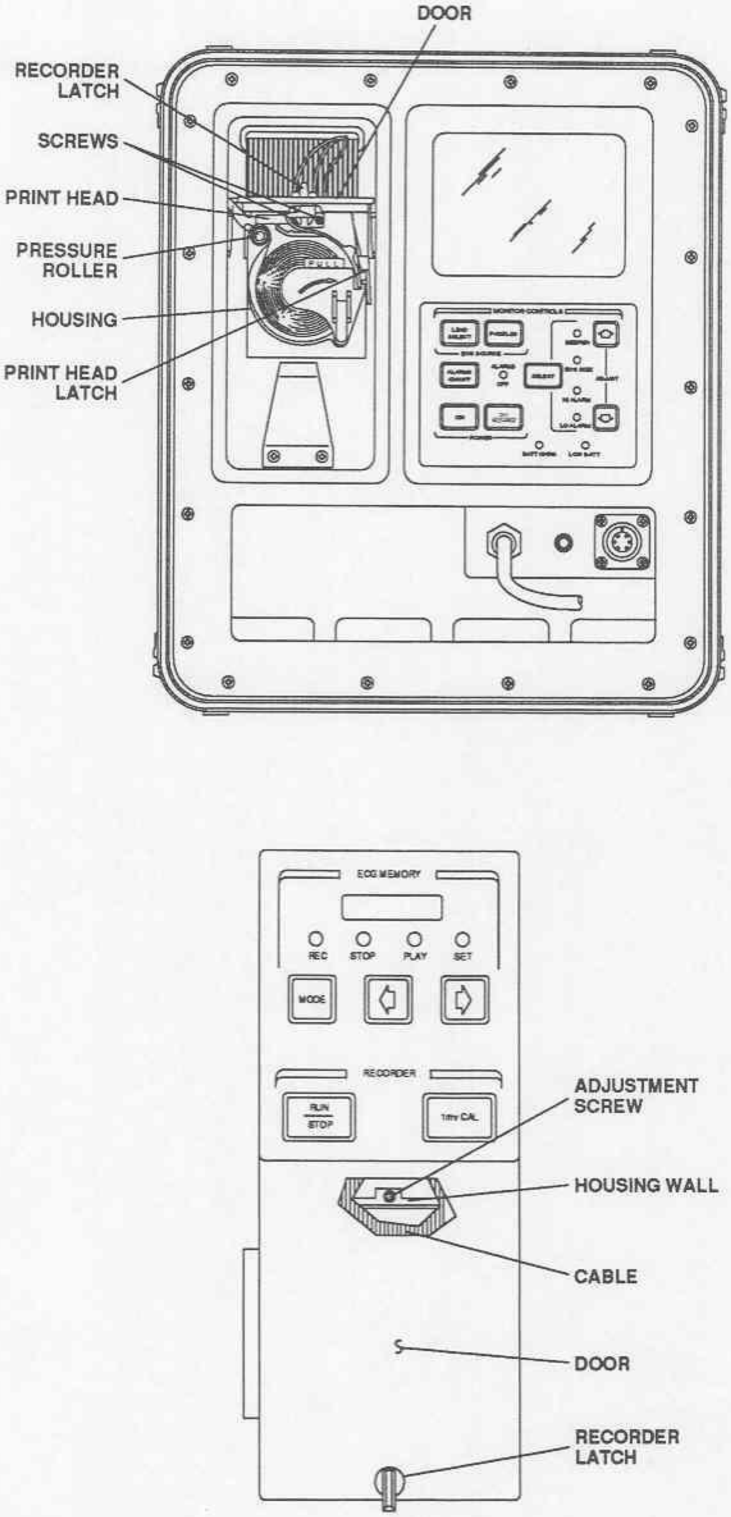

DOOR
RECORDER LATCH
SCREWS
PRINT HEAD
PRESSURE ROLLER
HOUSING
PRINT HEAD LATCH
ECG MEMORY
REC
STOP
PLAY
SET
MODE
RECORDER
RUN
STOP
1mv CAL
ADJUSTMENT SCREW
HOUSING WALL
CABLE
DOOR
RECORDER LATCH

Figure 3-7. Printhead Cleaning and Alignment.

3-16. PRINTHEAD ALIGNMENT

The printhead needs alignment if the print is darker on one half of the paper than the other half.

NOTES

Always clean the printhead before performing the alignment procedure to verify that the cause is misalignment and not a dirty printhead.

The printhead alignment is a difficult adjustment to make, because the Recorder must be disassembled to access the adjustment screw.

1. Clean printhead (paragraph 3-15). Operate recorder and verify that the print is darker on one half of the paper than the other half.
   - If it still is , proceed with step 2.
   - If not, the printhead was just dirty and the recorder is operational.
2. Remove the A3A1 Recorder Assembly (Section IV, paragraph 4-14).
3. Remove the two screws in the bottom of the Recorder next to the recorder latch, and separate the recorder housing from the recorder door. Separate only enough to gain access to the adjustment set screw. The set screw is located underneath the flat ribbon cable on the upper printhead housing wall.

CAUTION

Take care when separating the housing from the door as not to damage any cables.

4. Position the Recorder Assembly next to the Monitor-Recorder and reconnect the following wires:
   - 40 pin ribbon cable A3A1A2P4 to A2A2J4.
   - 2 wire cable A3A1A2P45 to A2A5J3.
   - Green/Yellow ground wire to chassis with nut and washer.
5. On the Monitor-Recorder Module:
   - Press the POWER OFF key.
   - Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a ramp waveform followed by a stair step waveform.
   - Press the RUN/STOP key and verify the recorder prints the same ramp waveform followed by a stair step waveform as the CRT.

NOTE

It is normal for the ramp portion of the waveform to be clipped on the top and bottom on the printed output.

6. Using a hex key, adjust the set screw on the upper printhead housing wall until the bottom half of the paper is printing light, then back off the set screw until the bottom half darkens to the same intensity as the top half.

WARNING

The recorder assembly may have to be physically held in order to perform adjustment. Dangerous voltages are present when the covers are removed.

NOTE

Adjusting for greater darkening on the top half can cause paper tracking problems.

7. Allow the recorder to run for approximately 30 seconds to verify the intensity remains the same for top and bottom, and that the paper tracks correctly. If not, repeat step 6.
8. Reassemble the recorder housing and the recorder door, and replace the two screws in the bottom of the recorder next to the recorder door latch.
9. Install the A3A1 Recorder Assembly (Section IV, paragraph 4-14).
10. Repeat step 5 and verify print intensity and tracking are correct. If not, repeat procedure.

4-1. INTRODUCTION

This section describes the procedures used to remove and replace the following items:

- Monitor-Recorder Module (from case).
- Battery Assembly (BT1).
- Infrared Link Circuit Card Assembly (CCA) (A1A1).
- Chassis Assembly (A2).
- Power Supply CCA (A2A1).
- Control CCA (A2A2).
- ECG/Power Supply CCA (A2A3).
- ECG Memory CCA (A2A4).
- CRT Deflection CCA (A2A5).
- Deflection Yoke Assembly (A2L1).
- CRT Assembly (A2V1).
- Front Panel Assembly (A3).
- Recorder Assembly (A3A1).
- Recorder Display CCA (A3A1A1).
- Recorder Interface CCA (A3A1A2).
- Recorder Membrane Switch Assembly (A3A1A3).
- Recorder Mechanical Assembly.
- Recorder Printhead Replacement.
- Monitor Control Display CCA (A3A2).
- Monitor Control Membrane Switch Assembly (A3A3).

Illustrations are provided at the end of this section to identify all the items referenced (both by name and reference designator) in the following procedures.

- Monitor-Recorder Front View - figure 4-1.
- Monitor-Recorder Top View - figure 4-2.
- Monitor-Recorder Right Side View - figure 4-3.
- Monitor-Recorder Left Side View - figure 4-4.
- Recorder Assembly - figure 4-5.

Reverse disassembly instructions to reassemble. Use the torque chart listed below when re-tightening hardware.

No. 2 Screw	2 in-lbs
No. 4 Screw	6 in-lbs
No. 6 Screw	8 in-lbs
No. 6 Screw with rubber washer	6 in-lbs
No. 8 Screw	12 in-lbs
No. 8 Plastic standoff	2 in-lbs
Strain relief on AC power cord	10 in-lbs

4-2. MONITOR-RECORDER MODULE

WARNING

DISCONNECT THE MONITOR-RECORDER FROM THE A.C. POWER SOURCE BEFORE PROCEEDING.

THIS UNIT IS BATTERY POWERED, CAUSING DANGEROUS VOLTAGES TO BE PRESENT EVEN WITH AC POWER SOURCE REMOVED.

1. Disconnect AC power cord from AC source.
2. Press the POWER OFF key.
3. Working from front, remove 18 screws and washers holding Monitor-Recorder module front panel.
4. Slide Monitor-Recorder module out of case enough to disconnect A1A1 Infrared Link CCA 10 pin ribbon cable A1A1P36 from the A2A2 Control CCA.
5. Remove Monitor-Recorder module.
6. Disconnect 3 wire battery cable BT1P14.

4-3. BATTERY ASSEMBLY (BT1)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Working from left side, disconnect 3 wire cable BT1P14 and battery vent tube.
3. Remove two screws with washers, and battery retainer.
4. Remove BT1 Battery Assembly.
5. When installing the Battery Assembly, make sure the vent hole and BT1P14 are facing up. Reconnect battery vent tube.

4-4. INFRARED LINK CCA (A1A1)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Working from inside the case, remove two screws and washers.
3. Remove A1A1 Infrared Link CCA.
4. When installing A1A1 Infrared Link CCA, make sure 10 pin ribbon cable A1A1P36 is positioned on top and components are facing towards window.

4-5. CHASSIS ASSEMBLY (A2)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Disconnect the following wires (tag before disconnecting if necessary):
   - 6 wire cable A3P26 (A2A2J26).
   - 14 pin ribbon cable A3A3P33 (A2A2J33).
   - 40 pin ribbon cable A3A1A2P4 (A2A2J4).
   - 2 wire cable A3P37 (A2A2J37).
   - 2 wire cable A3A1A2P45 (A2A5J3).
   - Remove nut and washer holding Green/Yellow ground wire (on top left side). Disconnect Green/Yellow ground wire.
4. Remove three screws and chassis brace.
5. Remove four screws, washers, and spacers holding A2 Chassis Assembly to A3 Front Panel Assembly. The two screws on the bottom (in front) remain in place.
6. Carefully separate A2 Chassis Assembly from A3 Front Panel Assembly enough to disconnect the following wires:
   - 3 wire cable A3P19 (A2A3J26).
   - Remove three nuts and washers holding Green/Yellow ground wires (on bottom left side). Disconnect Green/Yellow ground wires.
7. Verify that all the cables and wires are clear from retaining clamps and wraps.
8. Separate A2 Chassis Assembly from A3 Front Panel Assembly.
9. When installing the A2 Chassis Assembly, make sure the cables and wires are routed in the proper holes, clamps, and wraps.

4-6. POWER SUPPLY CCA (A2A1)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A2 Chassis Assembly (paragraph 4-5).
4. Disconnect the following wires (tag before disconnecting if necessary):
   - Wiring harness A2P20 (A2A1 6 pin connector).
5. Working from bottom, remove four screws and washers.
6. Remove A2A1 Power Supply CCA.
7. When installing the A2A1 Power Supply CCA, make sure heatsink is toward rear.

4-7. CONTROL CCA (A2A2)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A2A3 ECG/Power Supply CCA (paragraph 4-8).
4. Disconnect the following wires (tag before disconnecting if necessary):
   - 14 pin ribbon cable A3A3P33 (A2A2J33).
   - 40 pin ribbon cable A3A1A2P4 (A2A2J4).
   - 2 wire cable A3P37 (A2A2J37).
   - 10 pin ribbon cable A2A5P31 (A2A2J31).
5. Verify that all the cables and wires are clear from retaining clamps and wraps.
6. Unscrew eight retainer posts and remove A2A2 Control CCA from A2 Chassis Assembly.
7. When installing A2A2 Control CCA, make sure the cables and wires are routed in the proper holes, clamps, and wraps. Install with component side facing forward. Tighten eight retainer posts with fingers only (no tools) to ~2 in-lbs nominal.

4-8. ECG/POWER SUPPLY CCA (A2A3)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).

3. Disconnect the following wires (tag before disconnecting if necessary):
   - 6 wire cable A3P26 (A2A3J26).
   - 24 pin ribbon cable A2A2P30 (A2A3J30).
   - 2 wire cable A3A1A2P45 (A2A3J3).
   - Wiring harness A2P20 (A2A3J2).
4. Remove one screw and washer holding Green ground wire from chassis. Disconnect Green ground wire.
5. Verify that all the cables and wires are clear from retaining clamps and wraps.
6. Pinch eight retainer posts and lift A2A3 ECG/Power Supply CCA.
7. Remove A2A3 ECG/Power Supply CCA from A2A2 Control CCA.
8. When installing A2A2 Control CCA, make sure the cables and wires are routed in the proper holes, clamps, and wraps. Install with component side facing forward.

4-9. ECG MEMORY CCA (A2A4)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A2A3 ECG/Power Supply CCA (paragraph 4-8).
4. Remove A2A2 Control CCA (paragraph 4-7).
5. Pinch two retainer posts and lift A2A4 ECG Memory CCA.
6. Remove A2A4 ECG Memory CCA from A2A2 Control CCA.

4-10. CRT DEFLECTION CCA (A2A5)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Disconnect the following wires (tag before disconnecting if necessary):
   - Wiring harness A2P20 (A2A5J52).
   - 10 pin ribbon cable A2A5P31 (A2A2J31).
   - 4 wire cable A2L1P54 (A2A5J54).
   - 6 wire cable A2P53 (A2A5J53).
   - HV Lead A2A5P51 (CRT).

WARNING

High voltage is present on the anode of the CRT (A2V1) when power is removed. After disconnecting lead from A2V1, short anode of A2V1 to chassis ground using an insulated screwdriver.

4. Remove three screws and chassis brace.
5. Verify that all the cables and wires are clear from retaining clamps and wraps.
6. Working from top, remove four screws with washers.
7. Remove A2A5 CRT Deflection CCA from right side.
8. When installing the A2A5 CRT Deflection CCA, make sure the cables and wires are routed in the proper holes, clamps, and wraps. Install in right side with component side facing up.

4-11. DEFLECTION YOKE ASSEMBLY (A2L1)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A2A3 ECG/Power Supply CCA (paragraph 4-8).
4. Remove A2A2 Control CCA (paragraph 4-7).
5. Disconnect the following wires (tag before disconnecting if necessary):
   - 6 wire cable A2P53 (rear CRT).
   - 4 wire cable A2L1P54 (A2A5J54).

6. Verify that all the cables and wires are clear from retaining clamps and wraps.
7. Loosen yoke retainer screw.
8. Slide A2L1 Deflection Yoke Assembly to rear and remove.
9. After installing the A2L1 Deflection Yoke Assembly, perform CRT Display Adjustments (Section III, paragraph 3-12).

4-12. CRT ASSEMBLY (A2V1)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A2 Chassis Assembly (paragraph 4-5).
4. Disconnect the following wires (tag before disconnecting if necessary):
   - 6 wire cable A2P53 (rear CRT).
   - 4 wire cable A2L1P54 (A2A5J54).
   - HV Lead A2A5P51 (CRT).

WARNING

High voltage is present on the anode of the CRT (A2V1) when power is removed. After disconnecting lead from A2V1, short anode of A2V1 to chassis ground using an insulated screwdriver.

5. Verify that all the cables and wires are clear from retaining clamps and wraps.
6. Working from front, remove four screws with lockwashers and flat washers. Remove A2V1 CRT and A2L1 Deflection Yoke Assembly.
7. Loosen yoke retainer.
8. Slide A2L1 Deflection Yoke Assembly to rear and remove from A2V1 CRT Assembly.
9. Installing the A2L1 Deflection Yoke Assembly on A2V1 CRT Assembly. Make sure the cables and wires are routed in the proper holes, clamps, and wraps. After installation, perform CRT Display Adjustments (Section III, paragraph 3-12).

4-13. FRONT PANEL ASSEMBLY (A3)

1. Follow procedures provided for A2 Chassis Assembly (paragraph 4-5).

4-14. RECORDER ASSEMBLY (A3A1)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Disconnect the following wires (tag before disconnecting if necessary):
   - 40 pin ribbon cable A3A1A2P4 (A2A2J4).
   - 2 wire cable A3A1A2P45 (A2A5J3).
   - Remove nut and washer holding Green/Yellow ground wire (on top left side). Disconnect Green/Yellow ground wire.
4. Remove A2 Chassis Assembly (paragraph 4-5).
5. Working from rear, remove two rubber cable retainers.
6. Working from rear, remove inner recorder shaft E ring clip and washer. Support A3A1 Recorder Assembly and slide shaft out.
7. Feed cable through hole and remove A3A1 Recorder Assembly.
8. When installing A3A1 Recorder Assembly:
   - Feed cables through hole.
   - Slide in shaft and replace washers and retainers.
   - Install cable retainers.

4-15. RECORDER DISPLAY CCA (A3A1A1)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A3A1 Recorder Assembly (paragraph 4-14).
4. Working from back of A3A1 Recorder Assembly, remove two screws with washers, and two cable retainers.

5. Disconnect the following wires (tag before disconnecting if necessary):
   - 16 pin ribbon cable A3A1A1P41 (A3A1A2J41).
6. Lift top edge and remove A3A1A1 Recorder Display CCA.
7. When installing A3A1A1 Recorder Display CCA, place bottom edge in first. Make sure indicators align with front panel holes.

4-16. RECORDER INTERFACE CCA (A3A1A2)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A3A1 Recorder Assembly (paragraph 4-14).
4. Working from back of A3A1 Recorder Assembly, remove two screws, washers, and two cable retainers.
5. Disconnect the following wires (tag before disconnecting if necessary):
   - 16 pin ribbon cable A3A1A1P41 (A3A1A2J41).
   - 9 pin ribbon cable A3A1A3P42 (A3A1A2J42).
   - 20 pin ribbon cable A3A1P43 (A3A1A2J43).
   - 6 wire cable A3A1P44 (A3A1A2J44).
6. Working from top of A3A1 Recorder Assembly, remove three screws and washers.
7. Remove A3A1A2 Recorder Interface CCA.
8. When installing A3A1A2 Recorder Interface CCA, make sure the cables and wires are routed in the proper holes, clamps, and wraps.

4-17. RECORDER MEMBRANE SWITCH ASSEMBLY (A3A1A3)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A3A1 Recorder Assembly (paragraph 4-14).
4. Remove A3A1A2 Recorder Interface CCA (paragraph 4-16).
5. Working from A3A1 Recorder Assembly front, peel A3A1A3 Recorder Membrane Switch Assembly and remove (note cable routing).
6. When installing new A3A1A3 Recorder Membrane Switch Assembly, make sure front panel surface is clean and dry. Take care not to kink the switch connector tail.

4-18. RECORDER MECHANICAL ASSEMBLY

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A3A1 Recorder Assembly (paragraph 4-14).
4. Remove A3A1A2 Recorder Interface CCA (paragraph 4-16).
5. Working from bottom of A3A1 Recorder Assembly, remove two screws and washers.
6. Remove Recorder Mechanical Assembly.
7. When installing Recorder Mechanical Assembly, make sure the cables and wires are routed in the proper holes, clamps, and wraps.

4-19. RECORDER PRINTHEAD REPLACEMENT

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A3 Front Panel Assembly (paragraph 4-13).
4. Remove A3A1 Recorder Assembly (paragraph 4-14).
5. Remove A3A1A2 Recorder Interface CCA (paragraph 4-16).
6. Remove Recorder Mechanical Assembly (paragraph 4-18).
7. Remove two screws and printhead latch.
8. Remove two printhead springs.
9. Remove rear retainer and pivot pin.

10. Remove printhead assembly.
11. When installing new printhead:
    - Verify that front pivot pin is in between adjustment screw and spring.
    - Verify that rear pivot pin and retainer is in place.
    - Make sure printhead springs are centered on tabs/holes.
    - After installation is complete, perform Printhead Alignment (Section III, paragraph 3-16).

4-20. MONITOR CONTROL DISPLAY CCA (A3A2)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A3 Front Panel Assembly (paragraph 4-13).
4. Working from back of A3 Front Panel Assembly, remove four screws with washers.
5. Disconnect the following wires (tag before disconnecting if necessary):
    - 12 pin ribbon cable A3A3P10 (A3A2J10).
6. Remove A3A2 Monitor Control Display CCA.
7. When installing A3A2 Monitor Control Display CCA, make sure indicators align with front panel holes.

4-21. MONITOR CONTROL MEMBRANE SWITCH ASSEMBLY (A3A3)

1. Remove Monitor-Recorder module from case (paragraph 4-2).
2. Remove BT1 Battery Assembly (paragraph 4-3).
3. Remove A3 Front Panel Assembly (paragraph 4-13).
4. Remove A3A2 Monitor Control Display CCA (paragraph 4-19).
5. Working from A3 Front Panel Assembly front, peel A3A3 Monitor Control Membrane Switch Assembly and remove.
6. When installing new A3A3 Monitor Control Membrane Switch Assembly, make sure front panel surface is clean and dry. Take care not to kink the switch connector tail.

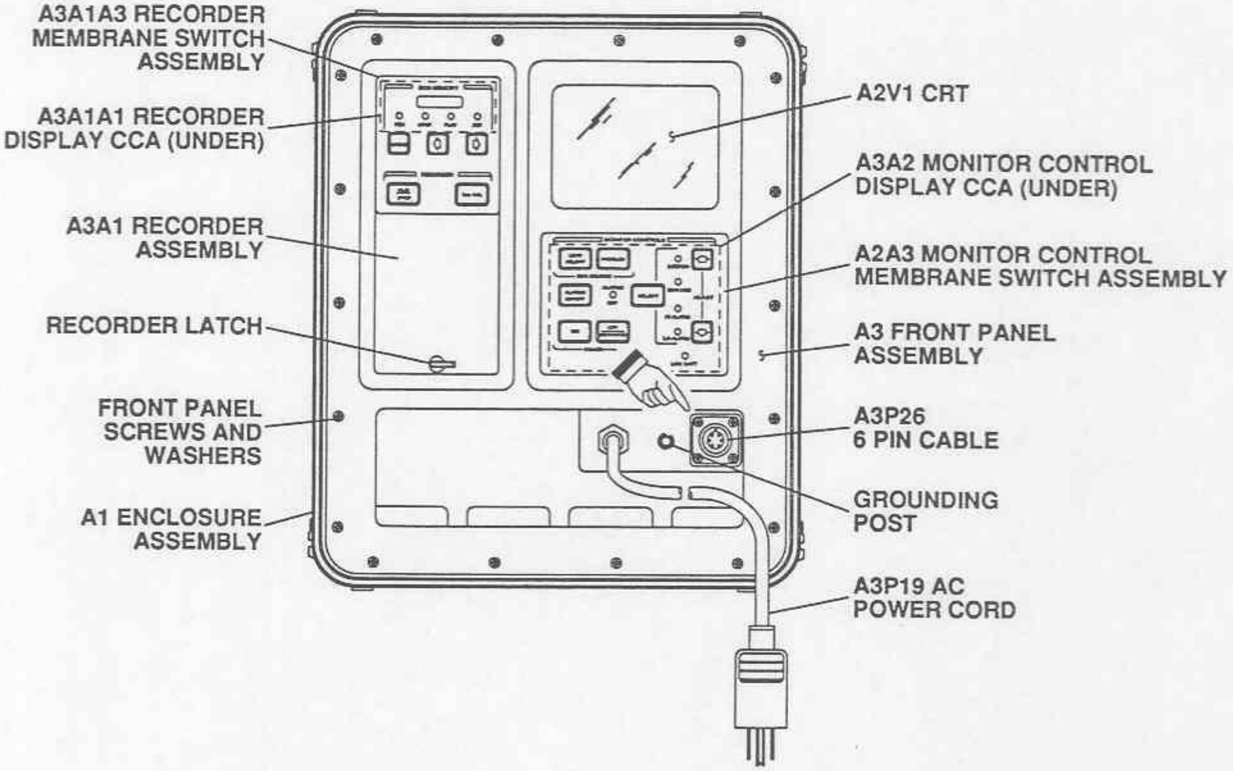

A3A1A3 RECORDER MEMBRANE SWITCH ASSEMBLY
A3A1A1 RECORDER DISPLAY CCA (UNDER)
A3A1 RECORDER ASSEMBLY
RECORDER LATCH
FRONT PANEL SCREWS AND WASHERS
A1 ENCLOSURE ASSEMBLY
A2V1 CRT
A3A2 MONITOR CONTROL DISPLAY CCA (UNDER)
A2A3 MONITOR CONTROL MEMBRANE SWITCH ASSEMBLY
A3 FRONT PANEL ASSEMBLY
A3P26 6 PIN CABLE
GROUNDING POST
A3P19 AC POWER CORD

Figure 4-1. Monitor-Recorder Front View.

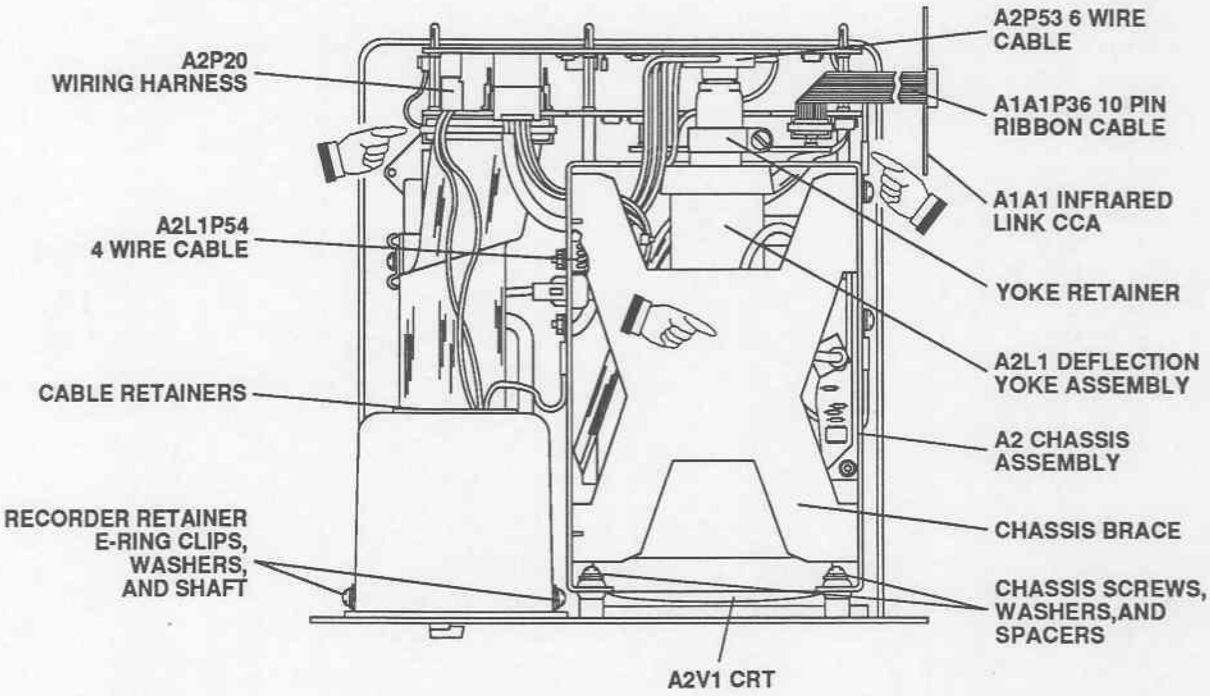

A2P20 WIRING HARNESS
A2L1P54 4 WIRE CABLE
CABLE RETAINERS
RECORDER RETAINER E-RING CLIPS, WASHERS, AND SHAFT
A2P53 6 WIRE CABLE
A1A1P36 10 PIN RIBBON CABLE
A1A1 INFRARED LINK CCA
YOKE RETAINER
A2L1 DEFLECTION YOKE ASSEMBLY
A2 CHASSIS ASSEMBLY
CHASSIS BRACE
CHASSIS SCREWS, WASHERS,AND SPACERS
A2V1 CRT

Figure 4-2. Monitor-Recorder Top View.

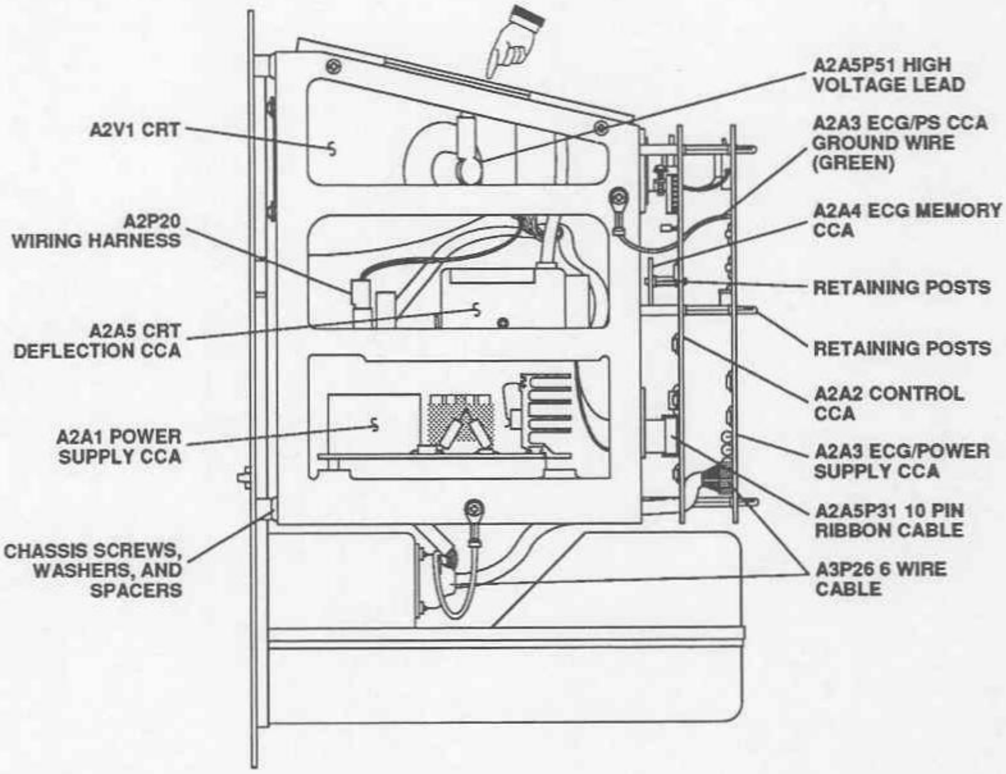

A2V1 CRT
A2P20 WIRING HARNESS
A2A5 CRT DEFLECTION CCA
A2A1 POWER SUPPLY CCA
CHASSIS SCREWS, WASHERS, AND SPACERS
A2A5P51 HIGH VOLTAGE LEAD
A2A3 ECG/PS CCA GROUND WIRE (GREEN)
A2A4 ECG MEMORY CCA
RETAINING POSTS
RETAINING POSTS
A2A2 CONTROL CCA
A2A3 ECG/POWER SUPPLY CCA
A2A5P31 10 PIN RIBBON CABLE
A3P26 6 WIRE CABLE

Figure 4-3. Monitor-Recorder Right Side View.

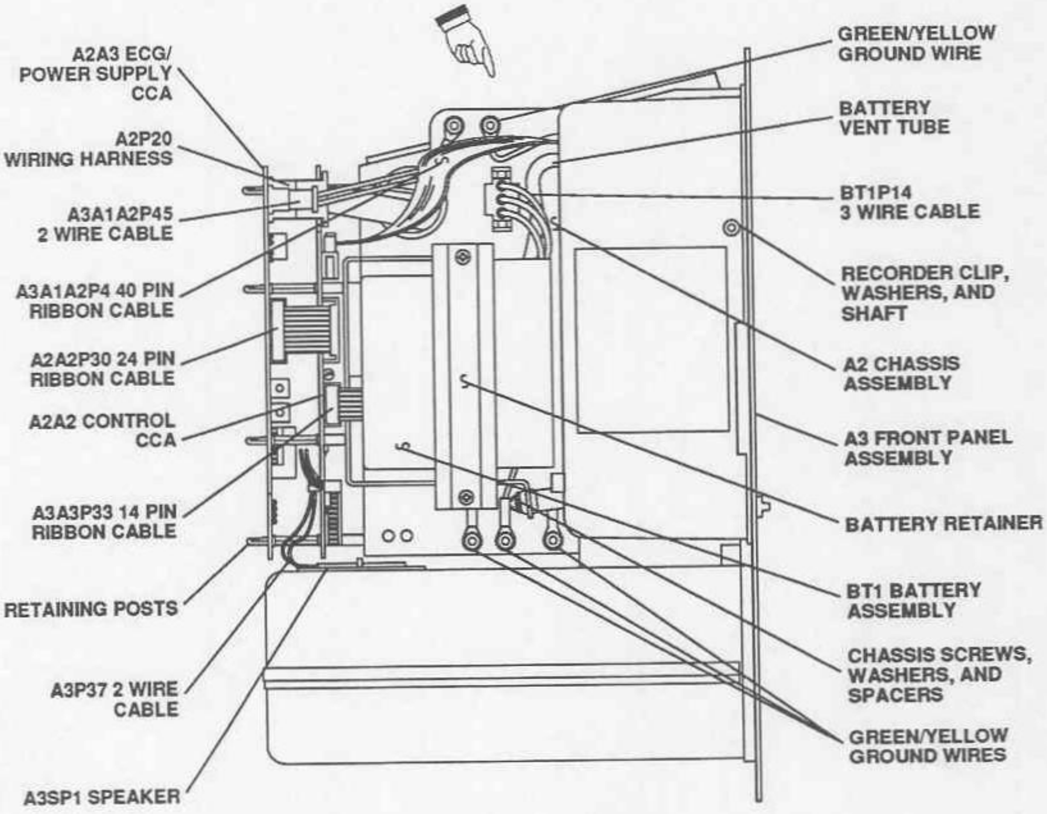
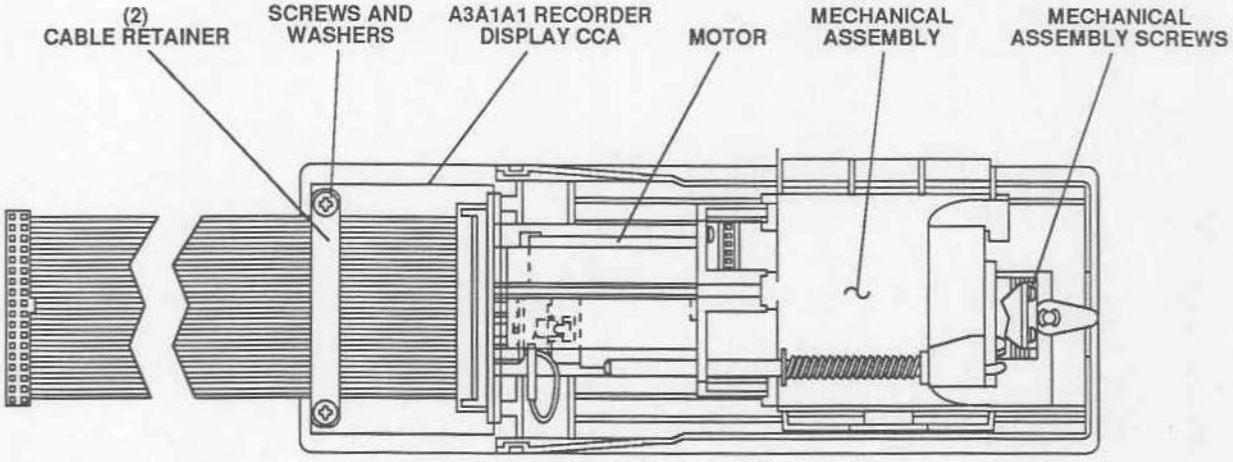
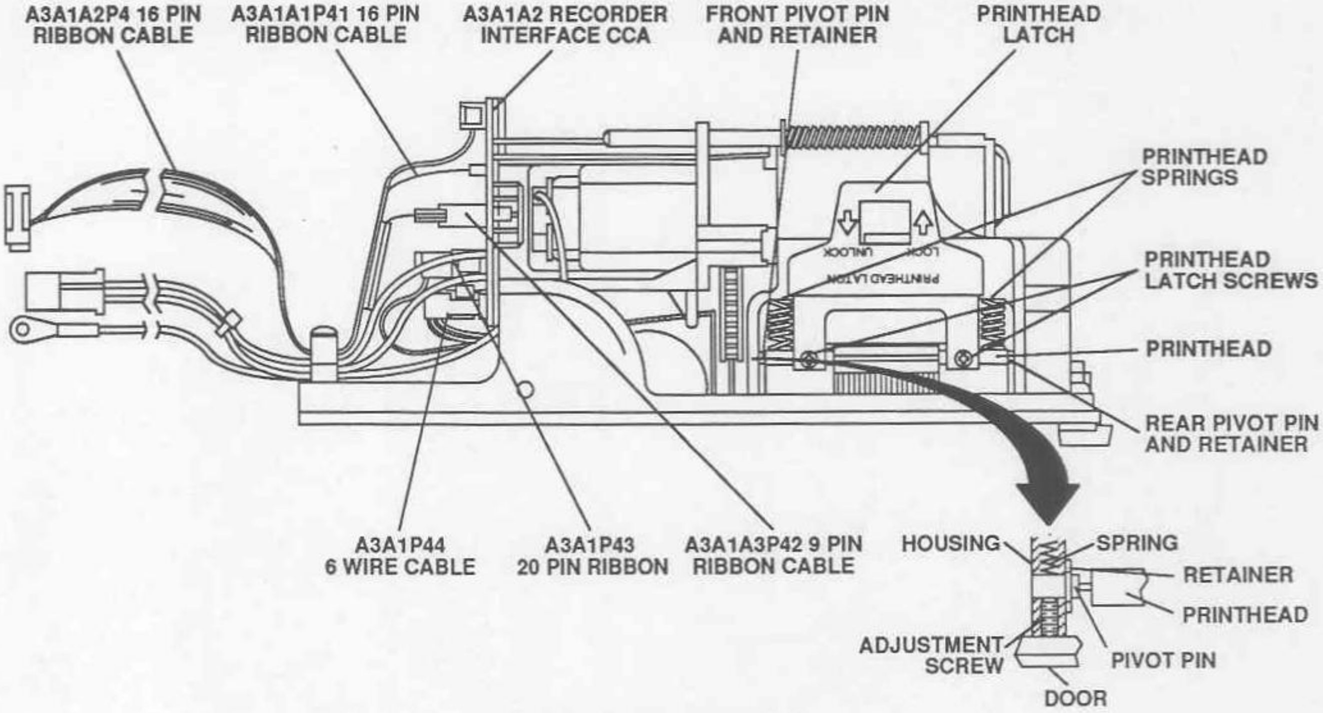

A2A3 ECG/ POWER SUPPLY CCA
A2P20 WIRING HARNESS
A3A1A2P45 2 WIRE CABLE
A3A1A2P4 40 PIN RIBBON CABLE
A2A2P30 24 PIN RIBBON CABLE
A2A2 CONTROL CCA
A3A3P33 14 PIN RIBBON CABLE
RETAINING POSTS
A3P37 2 WIRE CABLE
A3SP1 SPEAKER
GREEN/YELLOW GROUND WIRE
BATTERY VENT TUBE
BT1P14 3 WIRE CABLE
RECORDER CLIP, WASHERS, AND SHAFT
A2 CHASSIS ASSEMBLY
A3 FRONT PANEL ASSEMBLY
BATTERY RETAINER
BT1 BATTERY ASSEMBLY
CHASSIS SCREWS, WASHERS, AND SPACERS
GREEN/YELLOW GROUND WIRES

Figure 4-4. Monitor-Recorder Left Side View.


(2)
CABLE RETAINER
SCREWS AND WASHERS
A3A1A1 RECORDER DISPLAY CCA
MOTOR
MECHANICAL ASSEMBLY
MECHANICAL ASSEMBLY SCREWS

REAR VIEW


A3A1A2P4 16 PIN RIBBON CABLE
A3A1A1P41 16 PIN RIBBON CABLE
A3A1A2 RECORDER INTERFACE CCA
FRONT PIVOT PIN AND RETAINER
PRINTHEAD LATCH
PRINTHEAD SPRINGS
PRINTHEAD LATCH SCREWS
PRINTHEAD
REAR PIVOT PIN AND RETAINER
PRINTHEAD LATCH
LOCK
UNLOCK
A3A1P44 6 WIRE CABLE
A3A1P43 20 PIN RIBBON
A3A1A3P42 9 PIN RIBBON CABLE
HOUSING
SPRING
RETAINER
PRINTHEAD
ADJUSTMENT SCREW
PIVOT PIN
DOOR

RIGHT SIDE VIEW

Figure 4-5. Recorder Assembly.

5-1. INTRODUCTION

This section describes the procedures used to troubleshoot the Monitor-Recorder module. Other sections in the manual that will help in diagnosis of a malfunction are as follows:

- Section II - Theory of Operation. Contains information about circuit theory down to individual piece part levels. Schematic diagrams are referenced directly out of theory for ease of use in troubleshooting.
- Section III - Checks and Adjustments. Contains information about proper performance parameters and also post repair adjustments.
- Section VI - Replaceable Parts. Contains the necessary functional block diagrams, schematic diagrams, and component locators. Also contains voltages and waveforms necessary for troubleshooting.

5-2. TROUBLESHOOTING GUIDELINES.

The following is a list of aids that you can use when troubleshooting the Monitor-Recorder Module:

- Check all forms and tags attached to, or accompanying, the equipment to determine the reason for removal from service.
- The Monitor-Recorder Module will display error codes (listed in symptom index) for use in troubleshooting.
- Almost all Monitor-Recorder functions are confined to two circuit areas, one of which is the A2A2 Control CCA. Also, most problems in troubleshooting will be logical, i.e., if the recorder doesn't work the problem is likely on the Recorder Assembly , or the Control Circuit Card Assembly (CCA), etc.
- All functions rely on proper power, so remember to verify all operating voltages.
- Refer to the theory of operation (Section II) as required. This provides circuit theory of the section you are troubleshooting with references to the detailed functional and schematic diagrams.
- Circuit cooler spray can be used in isolating problems. The most generally used method is to spray suspected circuits/components to see if the malfunction can be temporarily fixed. This method will not work all the time, but it can be a great timesaver. It is especially helpful on intermittent problems that get worse with a rise in temperature.
- Problems on Monitor-Recorder Modules that have been in service for awhile may be caused by corrosion. Sometimes removing and reseating the affected cable will correct a malfunction. Cleaning connector pins and/or switch contacts with alcohol will repair many types of digital and analog circuit malfunctions.
- For microcircuit orientation, pin one is identified by a square solder pad on the printed circuit board.

5-3. SERVICE MODE.

The Monitor-Recorder can be placed in a special service mode to help with troubleshooting and adjustments. When in service mode, the Monitor-Recorder module will perform and display the following items:

- Generate and display (on CRT) a ramp and stair step waveform. Tests the CRT Deflection CCA, CRT (A2V1), and Yoke Assembly (A2L1). Also used to setup the Monitor-Recorder for making certain waveform readings.
- Generate and print (on Recorder) a ramp and stair step waveform. Tests the A3A1 Recorder Assembly. Also used during printhead alignment.
- Generate a beep to test the A2A2 Control CCA audio circuit.
- Measures and displays the battery voltage (BT1) when not connected to an AC source.
- Measures and displays the battery charging voltage (A2A3 ECG/Power Supply CCA) when connected to an AC source.
- Displays the currently selected GAIN mode and setting. Format is "xxxx a", where xxxx is the value from 250 to 4000, and "a" is automatic mode or a "blank" is manual mode. Present gain can also be changed.
- Measures and displays the peak to peak NOISE voltage present on the selected ECG channel, over a one second period.
- Measures and displays the OFFSET voltage of the selected ECG channel from the center of the Analog to Digital convertors input range.
- Measures and displays the number of bad IR LINK packets, out of a possible 240 packets per second, which are received via the A1A1 Infrared Link CCA.
- Displays the LFREQ Hz (line frequency), either 50 or 60 Hz, that the digital notch filter has chosen to reject.

1. To enter the service mode:
    - Press the POWER OFF key.
    - Press and hold the RIGHT and LEFT arrow keys, press the POWER ON key, then immediately press the SELECT key. Release the RIGHT and LEFT arrow keys. Verify the CRT screen shows a ramp waveform followed by a stair step waveform. Verify the presence of audio tone (beeping).
    - Press the SELECT key until the BEEPER indicator is on.
    - Press the UP and DOWN arrow keys simultaneously until "BATT xx.xV" is displayed on the CRT screen.
    - Press the UP and DOWN arrow keys simultaneously until "GAIN xxxx a" is displayed on the CRT screen. To change gain, press SELECT key until ECG SIZE indicator is on. Press the UP or DOWN arrow keys until desired gain is displayed on the CRT screen.
    - Verify the BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "NOISE xx.xV" is displayed on the CRT screen.
    - Verify the BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "OFFST xx.xV" is displayed on the CRT screen.
    - Verify the BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "IR LINK xxx" is displayed on the CRT screen.

- Verify the BEEPER indicator is on. Press the UP and DOWN arrow keys simultaneously until "LFREQ xx HZ" is displayed on the CRT screen.

2. To exit the service mode:

   - Press the POWER OFF key.

5-4. EQUIPMENT INSPECTION.

The following inspection procedures shall be used to locate obvious malfunctions in the Monitor-Recorder Module.

- Remove Monitor-Recorder Module from case (Section IV, paragraph 4-2) as required to access components.
- Inspect all external surfaces of Monitor-Recorder Module for physical damage, breakage, loose or dirty contacts, and missing components.

WARNINGS

Monitor-Recorder Module contains high voltages. After power is removed, discharge capacitors to ground before working inside to prevent electrical shock.

Disconnecting the AC power cord will not remove all dangerous voltages as the Monitor-Recorder Module operates from battery as well as AC power.

CAUTION

Do not disconnect or remove any board assemblies in the Monitor-Recorder Module unless the POWER is OFF. Some board assemblies contain devices that can be damaged if the board is removed when the power is on. Several components, including MOS devices, can be damaged by electrostatic discharge. Use conductive foam and grounding straps when servicing is required around sensitive components. Use care when unplugging IC's from high-grip sockets.

- Inspect printed circuit board surfaces for discoloration, cracks, breaks, and warping.
- Inspect printed circuit board conductors for breaks, cracks, cuts, erosion, or looseness.
- Inspect all assemblies for burnt or loose components.
- Inspect all chassis and panel mounted components for looseness, breakage, loose contacts or conductors.
- Inspect for disconnected, broken, cut, loose, or frayed cables or wires.

5-5. SYMPTOM INDEX

To begin troubleshooting, match the malfunction to an entry in the symptom index and perform the troubleshooting on the page referenced.

SYMPTOM INDEX

SYMPTOM	PAGE
Error Messages	5-5
System Dead	5-6
CRT Display Problems	5-8
Recorder Problems	5-11
ECG Signal Problems	5-12
Service Mode Problems	5-13
Battery/Battery Charger Problems	5-14
Low Voltage Supply Problems	5-15
Optical Link Problems	5-16

ERROR MESSAGES

SYMPTOM	SUSPECT AREA	CHECKS
CRT displays "ERROR 0".	Main Controller (A2A2U61) Error.	See System Dead Problems.
CRT displays "ERROR 1".	Recorder Controller Error.	A2A2U1 (RAM/ROM).
CRT displays "ERROR 2".	CRT and Display Controller Error.	A2A2U31 (RAM/ROM).
CRT displays "ERROR 3".	ECG Memory Error.	A2A4 ECG Memory CCA.
CRT displays "ERROR 6".	LV Supply out of spec.	See Low Voltage Supply Problems.
CRT displays "ERROR 7".	A/D Converter.	See System Dead Problems.
CRT displays "ERROR 8".	Recorder Motor failure.	See Recorder Problems.

SYSTEM DEAD

SYMPTOM	SUSPECT AREA	CHECKS
System dead.	Power.	Check battery voltage at A2A3J2 pins 8 and 9. Check for +14.3 V at A2A3J2 pins 2 and 3 when AC power cord is connected to AC source and BT1 is fully charged.
	A3A2 POWER ON Switch.	Check for continuity between A2A2J33 pin 11 and pin 14 (DGND) when POWER ON key is pressed. Check for continuity between A2A3J30 pin 2 and pin 6 (DGND) when POWER ON key is pressed.
	A2A3K102.	Use a jumper wire to force ~+12v across coil, and verify relay operates (click). If A2A3K102 is closed instrument should be on.
	A2A3U102.	Verify A2A3U102 pin 1 is low impedance when pin 8 is greater than 2.5 V above pin 6.
	A2A3F101.	Check Fuse.
Instrument will only stay on while ON switch is held.	A3A2Q1.	+5V FP should hold A3A2Q1 on, forcing the ON/OFF signal to ground.
V battery, +8V, +5 V –5 V correct, but instrument not on.	Clock Oscillator on A2A2.	Check A2A2U62 pins 7 and 8 for 12 MHz sine wave, with 5 V amplitude. Check A2A2U62 pin 9, and A2A2U61 pin 19 for 12 MHz square wave with 5 V amplitude.

SYSTEM DEAD — Continued

SYMPTOM	SUSPECT AREA	CHECKS
Continuous tone, no CRT display.	A2A2U61.	Check Vcc on A2A2U62 pins 18 and 68 for greater than 4.3V. Check A2A2U61 pin 40 for 4.7 to 5.3V. Check A2A2U63 pin 20 for 4.9 to 5.1V. Check A2A2U62 pin 2 for 0 to 5V signal, with period of 4.167 ms (240 Hz), and 30% duty cycle. Check A2A2U61 pin 9 for reset signal. Check for pins being stuck, high, low, or disconnected on external address/data bus. A2A2U61 pins 32 thru 39, A2A2U62 pins 10, 12 thru 14, 16, 17, 21, 22, and A2A2U63 pins 9, 11 thru 17 should be active. Check ALE signal between A2A2U61 pin 30 and U62 pin 4. Should be 2 MHz square wave with 300 ns logic high pulse.
Unit turns on but no "READY" message and no power up tone.	A2A2U62.	Check signal on A2A2C70 and A2A2U62 pin 3 during turn on. Should take several hundred milliseconds to charge to Vcc.
Unit turns on, CRT display frozen with "ERROR 0", may or may not have continuous tone.	A2A2U61.	Check "tickle" signal A2A2U62 pin 2 and "RESET" signal A2A2U61 pin 9.

CRT DISPLAY PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Characters short.	+8 Volt supply voltage reference.	See "Flat Trace".
	–5 Volt supply.	Check A2A2U34 pin 3 and A2A2U35 pin 4 for –5V.
Too bright or dim.	A2A2R35 and R37.	Check A2A2 R35 and R37 for proper value.
Display jumps.	+5 V supply.	Check +5 V for noise.
	Horizontal sweep signal.	Check A2A2U31 pin 7 for undistorted square wave.
No sync marker.	A2A2U33.	Check A2A2U33 pin 19 for sync pulse. Check A2A2R35 for proper value.
Character dots jitter.	A2A5 Vertical Deflection.	Check A2A2U35 pin 7 for same waveform as shown on CRT. Must be in service mode (paragraph 5-3). If OK, check A2A5U2 pins 5 and, 7 and A2A5U1 pins 8 and 14 for jitter on miniraster position of trace.
	A2A2C40 (damping).	Check proper value of A2A2C40.
	A2A2 Voltage reference.	VREF2 (A2A2C39/R32) for stable 5V.
Display baseline no characters.	A2A5 Vertical Deflection.	Check A2A2U35 pin 7 for same waveform as shown on CRT. Must be in service mode (paragraph 5-3). If OK, check A2A5U2 pins 5 and, 7 and A2A5U1 pins 8 and 14.
	A2L1 Deflection Yoke.	Check A2L1 resistance - approx 6Ω vertical and approx 40Ω horizontal.
	+8V supply.	Check A2A2U35 pin 8 for +8V.
	A2A2 Voltage reference.	Check VREF2 (A2A2C39/R32) equal to +5V.

CRT DISPLAY PROBLEMS — Continued

SYMPTOM	SUSPECT AREA	CHECKS
Characters short.	–5 volt supply.	Check A2A2J31 pin 2, A2A2U34 pin 3 and A2A2U35 pin 4 for –5V.
	A2A2 Voltage reference.	Check VREF2 (A2A2C39/R32) +5V.
Display Blank.	A2A5ZZ2.	Check A2A5ZZ2 +40V and +100V test points. Check A2A2U35 pin 4 for –5V.
	A2A2U33.	Check A2A2U33 pin 18 for intensity waveform as shown on fig. 6-5.
	A2A2U31.	Check intensity control signal from processor A2A2U31 pin 13 and 14. If either is stuck high or low suspect A2A2U31. If they are toggling, suspect A2A2U33.
	Intensity circuit, tube filament.	Check junction of A2A5DS1/R31 for waveform as shown on fig. 6-8. Check for filament current by plugging instrument in and measuring 1.2V drop across A2A5R32.
Too bright.	See "Display blank".	
Too dim.	See "Display blank".	
Intensity varies.	A2A5ZZ2.	Check A2A5ZZ2 +40V and +100V test points.
Left side of display different size than right side.	A2A5Q1 to Q4, U1.	Check base voltages on A2A5Q1 to Q4. If there is no signal suspect A2A5U1. Otherwise, suspect A2A5Q1 and Q4 for right side problems, and A2A5Q2 and Q3 for left side problems.
Top half of display different size than bottom half.	A2A5Q5 to Q8, U1.	Check base voltages on A2A5Q5 to Q8. If there is no signal suspect A2A5U1. Otherwise, suspect A2A5Q5 and Q8 for upper half problems, and A2A5Q6 and Q7 for bottom half problems.

CRT DISPLAY PROBLEMS — Continued

SYMPTOM	SUSPECT AREA	CHECKS
Vertical deflection shakes.	A2A5R25.	Check A2A5U2 pin 7. If not stable replace A2A5U2. If OK, verify value of A2A5R25.
NO ECG.	A2A2U31.	Check bus A2A2U31 pins 32 to 39 for activity. If none, suspect A2A2U31.
No ECG - letters OK.	A2A2U33.	Check all solder joints on A2A2U33.
	A2A5U31.	Check bus on A2A5U31 pin 32-39.
Flat trace - no characters.	+8 volt supply.	Check A2A2U35 pin 8 for +8V. Check A2A2U34 pin 13 for +8V.
	A2A2 Voltage reference.	Check VREF2 (A2A2C39/R32) +5V.

RECORDER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
False 'No Paper' message.	Paper rotating on spindle.	Paper core inner diameter too large (improper paper). Use P/N 40453A.
	A2A2R15; A3A1A2P4 pin 38.	4 ms low pulse every 32 ms.
	A2A2U3 pin 5.	Signal active every 32 ms.
No paper shut off.	A2A2U3 pin 5, A3A1A2R1, R2.	Signal level remains constant when A2A2Q5 turns on.
Will not run.	A2A2U1 pin 27, A2A2U3 pin 10, A3A1A2C2.	1 kHz signal variable duty cycle present.
	A3A1 Motor.	Interrupter on rear motor shaft turning freely.
	A3A1A3 Front panel switch.	Signal not reaching A2A2U1.
Erratic speed.	A2A2U3 pin 2, A3A1A2R3.	3.974 kHz signal 50% duty cycle present.
Runs for short period then shuts off (doesn't detect paper).	No paper.	Replace paper roll.
	A2A2Q5.	On every 32 ms for 4 ms.
	A2A2U3 pin 5.	Change when A2A2Q5 turns on.
	A3A1A2R1 and R2.	Verify current flows when A2A2Q5 turns on.
	Optodetector, A2A2U3 pin 5 and 6, A2A2Q5.	Clean lens.
Printing light, or missing top or bottom half.	A3A1 Printhead.	Adjust printhead (Section III, paragraph 3-16).
No printing.	A2A2U3 pin 4 A3A1A2P4 pin 10.	Alternating high-low signal every 250-1000 µsec.
Light printing.	A3A1 Printhead.	Needs cleaning.
	Battery low (<11.2 V).	Check voltage (paragraph 5-3). Troubleshoot low battery shutdown circuit.
	Improper paper.	Use P/N 40453A.
	Door.	Door not closing completely.

ECG SIGNAL PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
50/60 Hz noise on ECG trace.	Electromagnetically noisy environment.	Check grounding of nearby equipment.
	High electrode impedance.	Use Redux®(P/N 651-1024-050) creme, abraid skin.
	Patient cable.	Substitute another patient cable.
ECG noise, not 50/60 Hz.	A2A3 Isolated circuits.	Short across A2A3T201 pins 1 and 2 and observe.
		Short across A2A3C207 and observe.
		Short A2A3U205 pin 3 to A2A3U206 pin 3 and observe.
		Short A2A3R205, R208, R211, and R214 and observe.
	A2A3 Grounded circuits.	Short A2A3U304 pin 1 to ground and observe.
		Short junction of A2A3R312 and R313 to ground and observe.
		Short A2A3U302 pin 3 to ground and observe.
ECG Amp does not meet 0.5Hz bandwidth spec.	A2A3C302, R303 to R305.	Verify component values.
	A2A3Q301, Q302.	FAST_RESTORE A2A3J30 pin 16 should normally be low. A2A3Q302 and Q301 are normally OFF.
Leads ECG Offset from center of displays.	A2A3R308.	Adjust ECG Offset (Section III, paragraph 3-11).
	A2A3U302.	Verify offset voltage is <0.5 mV, and or input bias current is <50 pA on A2A3U302 pin 3.
ECG Gain Incorrect.	A2A3R311.	Adjust ECG gain (Section III, paragraph 3-10).
	A2A3U303.	Measure ON resistance for each of eight multiplexer channels.

SERVICE MODE PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Will not enter Service mode.	A2A2 Control CCA.	
	A3A1A3 LEFT/RIGHT arrow key.	Check for switch continuity (A3A1A3P42 pin 9 to 7, and 4 to 5).
No service ramp-step waveform on CRT or recorder.	A2A2U61.	
Ramp waveform is non-linear.	A2A5 CRT Deflection CCA.	

BATTERY/BATTERY CHARGER PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
Battery not charging, but LED is on.	BT1 Thermal Fuse.	Verify continuity between red and white wires (BT1P14 pins 1 and 3).
	BT1 Battery Assembly.	Check open circuit battery volts. Load test battery.
Battery not charging, LED is off, AC is connected.	A2A1 Power Supply CCA.	Verify 12 to 14.5 V at A2A3J2 pin 3 when AC is connected.
	A2A3K101.	Verify A2A3K101 is closed when AC is connected, and open when AC disconnected (audible click).
	A2A3U101.	Verify A2A3U101 pin 1 is high when AC is connected.
	A2A3Q101.	Verify A2A3Q101 gate is high and transistor is conducting when AC is connected.
Battery Charging LED not working.	A2A3U101.	A2A3U101 pin 7 should be low when AC is connected and battery is normal.
	A2A3Q102.	A2A3Q102 should be on when battery is charging. Trace signal path out to A3A2DS6.
Low battery shutdown not occurring.(Unit does not turn off when battery is below 11 V.	A2A3U102.	A2A3U102 should allow current to flow into pin 1 when pin 8 is 2.5V above pin 6, otherwise no current flows into pin 1.
	BT1 Battery Assembly.	If battery was discharged below 10.8 volts. Capacity may not recover. Replace BT1.

LOW VOLTAGE SUPPLY PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
+8V supply not operating correctly.	A2A3U103.	11 to 14 V on A2A3U103 pin 3.
+5V supply not operating correctly.	A2A3U104.	Square wave switching occurring on A2A3U104 pin 2.
–5V supply not operating correctly.	A2A3 +5V circuit.	Verify adequate load on +5V so that duty cycle at A2A3U104 pin 2 is not to short to allow charge pump to store charge on A2A3C110.
	A2A3U105.	Verify A2A3U105 pin 3 more negative then –8 V.

OPTICAL LINK PROBLEMS

SYMPTOM	SUSPECT AREA	CHECKS
"NO DEFIB", No communication between Monitor-Recorder and Defibrillator modules.	Optical Window	Clean optical window on both instruments and check for scratches. Try a different Defibrillator and a different Monitor-Recorder Put unit in service mode and read number of optical link errors reported by message (service mode paragraph 5-3). IR LINK 0 errors is normal.
	A2A2 Control CCA.	Verify activity on IR TRANSMIT signal line A1A1P36 pin 4.
	A1A1U2, Q1, DS3.	Verify activity by tracing signals along the path of these components.
	A1A1U1, U2.	Verify receive signal activity at collector of A1A1U1E pin 1 and output of A1A1U2B pin 7.

6-1. INTRODUCTION

This section of the service manual includes schematic diagrams and identifies major assemblies, subassemblies, and components of the 43200M/MC/MD Monitor-Recorder module to aid in ordering replacement parts and troubleshooting. Each entry in the material list tables includes the reference designation, HP part number, quantity used within the referenced assembly, a brief description of the part and the part number assigned by the manufacturer. Wherever possible, parts lists for the assemblies are printed on the same page as the schematic diagram and component location drawing or on immediate adjacent pages.

6-2. REFERENCE DESIGNATIONS

The parts listings use an alphabetical-numerical (alpha-numeric) method of listing the end item, assemblies, subassemblies and circuit components. These items are defined as follows:

1. An END ITEM is the instrument with all the supplied accessories. The END ITEM is made up of assemblies to aid in the location of parts.
2. Each assembly and subassembly is assigned an "A" number (A1, A2, A3, etc). Assemblies and subassemblies that can be purchased have part numbers in the part number column of the table; those that cannot be purchased do not have part numbers in the columns.
3. Components within the assembly and subassembly circuits are assigned circuit reference designators (C1 capacitor, R1 resistor, etc). These parts are prefaced by the assembly number (A1C1, A2C2, A1R1, A2R2, etc), to indicate the assembly on which the part is located.

An example of the alpha-numeric numbering method used to identify assemblies, subassemblies and circuit components is shown below:

A1 R 1

Assembly No.

Component Alpha Designation

Component Numeric Designation

6-3. FIGURE AND INDEX NUMBERS

Mechanical parts on some assemblies may be identified by an index number. These items are defined as follows:

1. Each assembly and subassembly is assigned an "6-" figure number (6-1, 6-2, etc).
2. Components within the assembly and subassembly circuits are assigned an index number (1, 2, 3, etc). These parts are prefaced by the assembly figure number (6-3-1, 6-4-12, etc), to indicate the assembly on which the part is located.

An example of the figure and index numbering method used to identify mechanical components is shown below:

6-1 -12

Assembly Fig. No.

Component Index Number

The complete figure and index number is read as the 6-1-12.

6-4. ORDERING INFORMATION

NOTE

Occasionally, electronic items in the replacement parts list will be found to carry standard commercial identification numbers but which also are indicated as being manufactured by HP. These components have been selected to meet specific operational criteria. The use of these components purchased through normal commercial channels may result in degradation of the operation performance or reliability of the unit.

To order a replacement part, address order or inquiry to the local Hewlett-Packard Sales/Service office (see list of addresses at the rear of the this manual) and supply the HP part number of the item from the listing.

To order a part not listed in a table, provide the following information:

1. Model number of the instrument.
2. Complete serial number of the instrument.
3. Description of the part including function and location.

To order a part from a manufacturer other than Hewlett-Packard Company, provide the complete part description and the manufacturer's part number from the listing. Manufacturer's codes are listed in Table 6-1.

Table 6-1. Manufacturer's Code

MFR NO.	MANUFACTURER NAME	ADDRESS		ZIP CODE
0003J	NIPPON ELECTRIC CO			
00853	SANGAMO ELEC CO S CAROLINA DIV	PICKENS	SC	29671
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01281	TRW INC SEMICONDUCTOR DIV	LAWNDALE	CA	90260
01295	TEXAS INSTR INC SEMICOND CMPNT DIV	DALLAS	TX	75222
0192B	RCA CORP SOLID STATE DIV	SOMERVILLE	NJ	08876
02111	SPECTROL ELECTRONICS CORP	CITY OF IND	CA	91745
03508	GE CO SEMICONDUCTOR PROD DEPT	SYRACUSE	NY	13201
03888	KDI PYROFILM CORP	WHIPPANY	NJ	07981
04222	AVX CERAMICS CORP	MYRTLE BEACH	SC	29577
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85062
07263	FAIRCHILD SEMICONDUCTOR DIV	MOUNTAIN VIEW	CA	94042
12617	HAMLIN INC	LAKE MILLS	WI	53551
13606	SPRAGUE ELECT CO SEMICOND DIV	CONCORD	NH	03301
17856	SILICONIX INC	SANTA CLARA	CA	95054
19701	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
20932	EMCON DIV ITW	SAN DIEGO	CA	92129
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
25088	SIEMENS CORP	ISELIN	NJ	08830
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	95051
27777	VARO SEMICONDUCTOR INC	GARLAND	TX	75040
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
32293	INTERSIL INC	CUPERTINO	CA	95014
34649	INTEL CORP	MOUNTAIN VIEW	CA	95051
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
71590	CENTRALAB ELEK DIV GLOBE-UNION INC	MILWAUKEE	WI	50501
72136	ELECTRO MOTIVE CORP SUB INC	WILLIMANTIC	CT	06226
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA	PA	19108
75915	LITTELFUSE INC	DES PLAINES	IL	60016
84411	TRW CAPACITOR DIV	OGALLALA	NE	69153

Table 6-2. Reference Designations and Abbreviations

REFERENCE DESIGNATIONS

A	assembly
AT	attenuator; isolator; termination
B	fan; motor
BT	battery
C	capacitor
CP	coupler
CR	diode; diode thyristor; varactor
DC	directional coupler
DL	delay line
DS	annunciator; signaling device (audible or visual); lamp; LED
E	miscellaneous electrical part
F	fuse
FL	filter
H	hardware
HY	circulator
J	electrical connector (stationary portion); jack
K	relay
L	coil; inductor
M	meter
MP	miscellaneous mechanical part
P	electrical connector (movable portion); plug
Q	transistor: SCR; triode thyristor
R	resistor
RT	thermistor
S	switch
T	transformer
TB	terminal board
TC	thermocouple
TP	test point
U	integrated circuit; microcircuit
V	electron tube
VR	voltage regulator; breakdown diode
W	cable; transmission path; wire
X	socket
Y	crystal unit (piezo-electric or quartz)
Z	tuned cavity; tuned circuit

ABBREVIATIONS

A	ampere
ac	alternating current
ACCESS	accessory
ADJ	adjustment
A/D	analog-to-digital
AF	audio frequency
AFC	automatic frequency control
AGC	automatic gain control
AL	aluminum
ALC	automatic level control
AM	amplitude modulation
AMPL	amplifier
APC	automatic phase control
ASSY	assembly
AUX	auxiliary
avg	average
AWG	American wire gauge
BAL	balance
BCD	binary coded decimal
BD	board
BE CU	beryllium copper
BFO	beat frequency oscillator
BH	binder head
BKDN	breakdown
BP	bandpass
BPF	bandpass filter
BRS	brass
BWO	backward-wave oscillator
CAL	calibrate
ccw	counter-clockwise
CER	ceramic
CHAN	channel
cm	centimeter
CMO	cabinet mount only
COAX	coaxial
COEF	coefficient
COM	common
COMP	composition
COMPL	complete
CONN	connector
CP	cadmium plate
CRT	cathode-ray tube
CTL	complementary transistor logic
CW	continuous wave
cw	clockwise
cm	centimeter
D/A	digital-to-analog
dB	decibel
dBm	decibel referred to 1 mW
dc	direct current
deg	degree (temperature interval or difference)
...°	degree (plane angle)
°C	degree Celsius (centigrade)
°F	degree Fahrenheit
°K	degree Kelvin
DEPC	deposited carbon
DET	detector
diam	diameter
DIA	diameter (used in parts list)
DIFF AMPL	differential amplifier
div	division
DPDT	double-pole, double-throw
DR	drive
DSB	double sideband
DTL	diode transistor logic
DVM	digital voltmeter
ECL	emitter coupled logic
EMF	electromotive force
EDP	electronic data processing
ELECT	electrolytic
ENCAP	encapsulated
EXT	external
F	farad
FET	field-effect transistor
F/F	flip-flop
FH	flat head
FIL H	fillister head
FM	frequency modulation
FP	front panel
FREQ	frequency
FXD	fixed
g	gram
GE	germanium
GHz	gigahertz
GL	glass
GRD	ground(ed)
H	henry
h	hour
HET	heterodyne
HEX	hexagonal
HD	head
HDW	hardware
HF	high frequency
HG	mercury
HI	high
HP	Hewlett-Packard
HPF	high pass filter
HR	hour (used in parts list)
HV	high voltage
Hz	Hertz
IC	integrated circuit
ID	inside diameter
IF	intermediate frequency
IMPG	impregnated
in	inch
INCD	incandescent
INCL	include(s)
INP	input
INS	insulation
INT	internal
kg	kilogram
kHz	kilohertz
kΩ	kilohm
kV	kilovolt
lb	pound
LC	inductance-capacitance
LED	light-emitting diode
LF	low frequency
LG	long
LH	left hand
LIM	limit
LIN	linear taper (used in parts list)
lin	linear
LK WASH	lock washer
LO	low; local oscillator
LOG	logarithmic taper (used in parts list)
log	logrithm(ic)
LPF	low pass filter
LV	low voltage
m	meter (distance)
mA	milliampere
MAX	maximum
MΩ	megohm
MEG	meg (10^6) (used in parts list)
MET FLM	metal film
MET OX	metallic oxide
MF	medium frequency; microfarad (used in parts list)
MFR	manufacturer
mg	milligram
MHz	megahertz
mH	millihenry
mho	mho
MIN	minimum
min	minute (time)
...'	minute (plane angle)
MINAT	miniature
mm	millimeter

NOTE

All abbreviations in the parts list will be in upper-case.

Table 6-2. Reference Designations and Abbreviations (cont'd)

MOD	modulator
MOM	momentary
MOS	metal-oxide semiconductor
ms	millisecond
MTG	mounting
MTR	meter (indicating device)
mV	millivolt
mVac	millivolt, ac
mVdc	millivolt, dc
mVpk	millivolt, peak
mVp-p	millivolt, peak-to-peak
mVrms	millivolt, rms
mW	milliwatt
MUX	multiplex
MY	mylar
μA	microampere
μF	microfarad
μH	microhenry
μmho	micromho
μs	microsecond
μV	microvolt
μVac	microvolt, ac
μVdc	microvolt, dc
μVpk	microvolt, peak
μVp-p	microvolt, peak-to-peak
μVrms	microvolt, rms
μW	microwatt
nA	nanoampere
NC	no connection
N/C	normally closed
NE	neon
NEG	negative
nF	nanofarad
NI PL	nickel plate
N/O	normally open
NOM	nominal
NORM	normal
NPN	negative-positive-negative
NPO	negative-positive zero (zero temperature coefficient)
NRFR	not recommended for field replacement
NSR	not separately replaceable
ns	nanosecond
nW	nanowatt
OBD	order by description
OD	outside diameter
OH	oval head
OP AMPL	operational amplifier
OPT	option
OSC	oscillator
OX	oxide
oz	ounce
Ω	ohm
P	peak (used in parts list)
PAM	pulse-amplitude modulation
PC	printed circuit
PCM	pulse-code modulation; pulse-count modulation
PDM	pulse-duration modulation
pF	picofarad
PH BRZ	phosphor bronze
PHL	Phillips
PIN	positive-intrinsic-negative
PIV	peak inverse voltage
pk	peak
PL	phase lock
PLO	phase lock oscillator
PM	phase modulation
PNP	positive-negative-positive
P/O	part of
POLY	polystyrene
PORC	porcelain
POS	positive; position(s) (used in parts list)
POSN	position
POT	potentiometer
p-p	peak-to-peak
PP	peak-to-peak (used in parts list)
PPM	pulse-position modulation
PREAMPL	preamplifier
PRF	pulse-repetition frequency
PRR	pulse repetition rate
ps	picosecond
PT	point
PTM	pulse-time modulation
PWM	pulse-width modulation
PWV	peak working voltage
RC	resistance-capacitance
RECT	rectifier
REF	reference
REG	regulated
REPL	replaceable
RF	radio frequency
RFI	radio frequency interference
RH	round head; right hand
RLC	resistance-inductance-capacitance
RMO	rack mount only
rms	root-mean-square
RND	round
ROM	read-only memory
R&P	rack and panel
RWV	reverse working voltage
S	scattering parameter
s	second (time)
..."	second (plane angle)
S-B	slow-blow (fuse) (used in parts list)
SCR	silicon controlled rectifier; screw
SE	selenium
SECT	sections
SEMICON	semiconductor
SHF	superhigh frequency
SI	silicon
SIL	silver
SL	slide
SNR	signal-to-noise ratio
SPDT	single-pole, double-throw
SPG	spring
SR	split ring
SPST	single-pole, single-throw
SSB	single sideband
SST	stainless steel
STL	steel
SQ	square
SWR	standing-wave ratio
SYNC	synchronize
T	timed (slow-blow fuse)
TA	tantalum
TC	temperature compensating
TD	time delay
TERM	terminal
TFT	thin-film transistor
TGL	toggle
THD	thread
THRU	through
TI	titanium
TOL	tolerance
TRIM	trimmer
TSTR	transistor
TTL	transistor-transistor logic
TV	television
TVI	television interference
TWT	traveling wave tube
U	micro (10^{-6}) (used in parts list)
UF	microfarad (used in parts list)
UHF	ultrahigh frequency
UNREG	unregulated
V	volt
VA	voltampere
Vac	volts, ac
VAR	variable
VCO	voltage-controlled oscillator
Vdc	volts, dc
VDCW	volts, dc, working (used in parts list)
V(F)	volts, filtered
VFO	variable-frequency oscillator
VHF	very-high frequency
Vpk	volts, peak
Vp-p	volts, peak-to-peak
Vrms	volts, rms
VSWR	voltage standing wave ratio
VTO	voltage-tuned oscillator
VTVM	vacuum-tube voltmeter
V(X)	volts, switched
W	watt
W/	with
WIV	working inverse voltage
WW	wirewound
W/O	without
YIG	yttrium-iron-garnet
Z_o	characteristic impedance

NOTE

All abbreviations in the parts list will be in upper-case.

MULTIPLIERS

Abbreviation	Prefix	Multiple
T	tera	10^{12}
G	giga	10^{9}
M	mega	10^{6}
k	kilo	10^{3}
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
μ	micro	10^{-6}
n	nano	10^{-9}
p	pico	10^{-12}
f	femto	10^{-15}
a	atto	10^{-18}

43200M Monitor (Without Front Cover)
See Figure 6-1 for Parts Breakdown

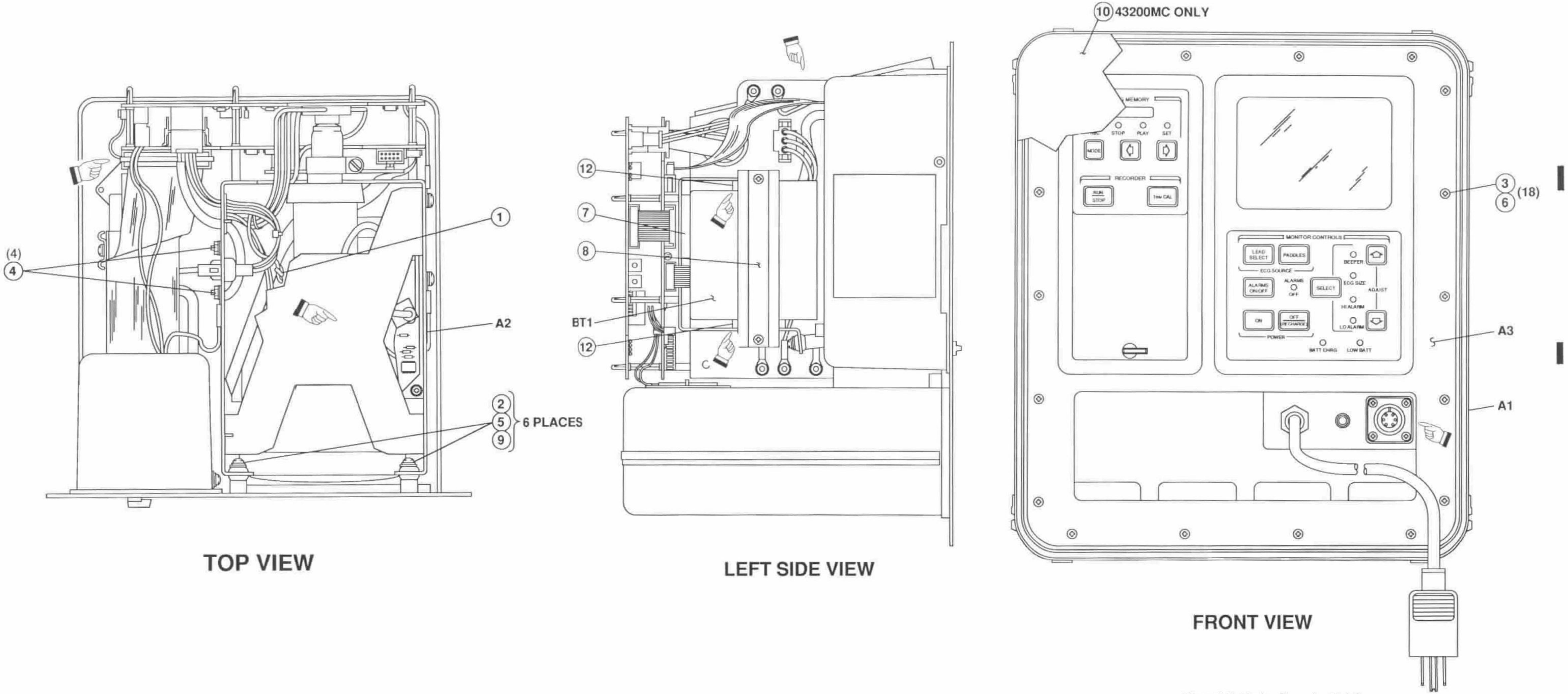
Reference Designator	Part Number	Qty	Description
A1	43201-67311	1	ENCLOSURE ASSY
A2	43201-67101	1	CHASSIS ASSY-MON
A3	43201-67202	1	FR PNL ASSY-MON
BT1	43131-67202	1	BATTERY ASSY
6-1-1	1400-1526	1	TWIST LOCK TIE
6-1-2	2190-0758	4	WASHER - 8-.5
6-1-3	2360-0121	18	PHMS-6-32X.5 P
6-1-4	2420-0006	4	NUT-HX LK WSHR
6-1-5	2510-0051	4	PHMS-8-32X.625 P
6-1-6	3050-1325	18	WSHR - SEAL 8
6-1-7	43201-07901	1	SPACER
6-1-8	43201-07307	1	RETAINER-BATT.
6-1-9	43201-27301	4	SPACER 8 THREAD
6-1-11	DELETED		
6-1-12	43201-07902	2	FOAM-BATT. BOX
	43131-84504	1	LABEL-NO BATT
	43201-84500	1	NAMEPLATE-S/N
	43201-87900	1	ACCESSORY KIT

43200MC Monitor (With Front Cover)
See Figure 6-1 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43201-67311	1	ENCLOSURE ASSY
A2	43201-67101	1	CHASSIS ASSY-MON
A3	43201-67202	1	FR PNL ASSY-MON
BT1	43131-67202	1	BATTERY ASSY
6-1-1	1400-1526	1	TWIST LOCK TIE
6-1-2	2190-0758	4	WASHER - 8-.5
6-1-3	2360-0121	18	PHMS-6-32X.5 P
6-1-4	2420-0006	5	NUT-HX LK WSHR
6-1-5	2510-0051	4	PHMS-8-32X.625 P
6-1-6	3050-1325	18	WSHR - SEAL 8
6-1-7	43201-07901	1	SPACER
6-1-8	43201-07307	1	RETAINER-BATT.
6-1-9	43201-27301	4	SPACER 8 THREAD
6-1-10	43201-60306	1	COVER
6-1-11	DELETED		
6-1-12	43201-07902	2	FOAM-BATT. BOX
	43131-84504	1	LABEL-NO BATT
	43201-84503	1	NAMEPLATE-S/N
	43201-87900	1	ACCESSORY KIT

43200MD Monitor (Used with Defibrillator)
See Figure 6-1 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43201-67311	1	ENCLOSURE ASSY
A2	43201-67101	1	CHASSIS ASSY-MON
A3	43201-67202	1	FR PNL ASSY-MON
BT1	43131-67202	1	BATTERY ASSY
6-1-1	1400-1526	1	TWIST LOCK TIE
6-1-2	2190-0758	4	WASHER - 8-.5
6-1-3	2360-0121	18	PHMS-6-32X.5 P
6-1-4	2420-0006	4	NUT-HX LK WSHR
6-1-5	2510-0051	4	PHMS-8-32X.625 P
6-1-6	3050-1325	18	WSHR - SEAL 8
6-1-7	43201-07901	1	SPACER
6-1-8	43201-07307	1	RETAINER-BATT.
6-1-9	43201-27301	4	SPACER 8 THREAD
6-1-11	DELETED		
6-1-12	43201-07902	2	FOAM-BATT. BOX
	43131-84504	1	LABEL-NO BATT
	43201-84511	1	NAMEPLATE-S/N
	43201-87900	1	ACCESSORY KIT


(4)
④
①
A2
②
⑤
⑨
6 PLACES
⑫
⑦
⑧
BT1
⑫
⑩ 43200MC ONLY
MEMORY
STOP
PLAY
SET
MODE
RECORDER
RUN
STOP
1mv CAL
MONITOR CONTROLS
LEAD SELECT
PADDLES
ECG SOURCE
ALARMS ON/OFF
ALARMS
OFF
SELECT
BEEPER
ECG SIZE
ADJUST
HI ALARM
LO ALARM
ON
OFF RECHARGE
POWER
BATT CHRG
LOW BATT
③
⑥ (18)
A3
A1

TOP VIEW

LEFT SIDE VIEW

FRONT VIEW

Figure 6-1. Monitor-Recorder Module Component Locator and Functional Block/ Wiring Diagram (Sheet 1 of 2).

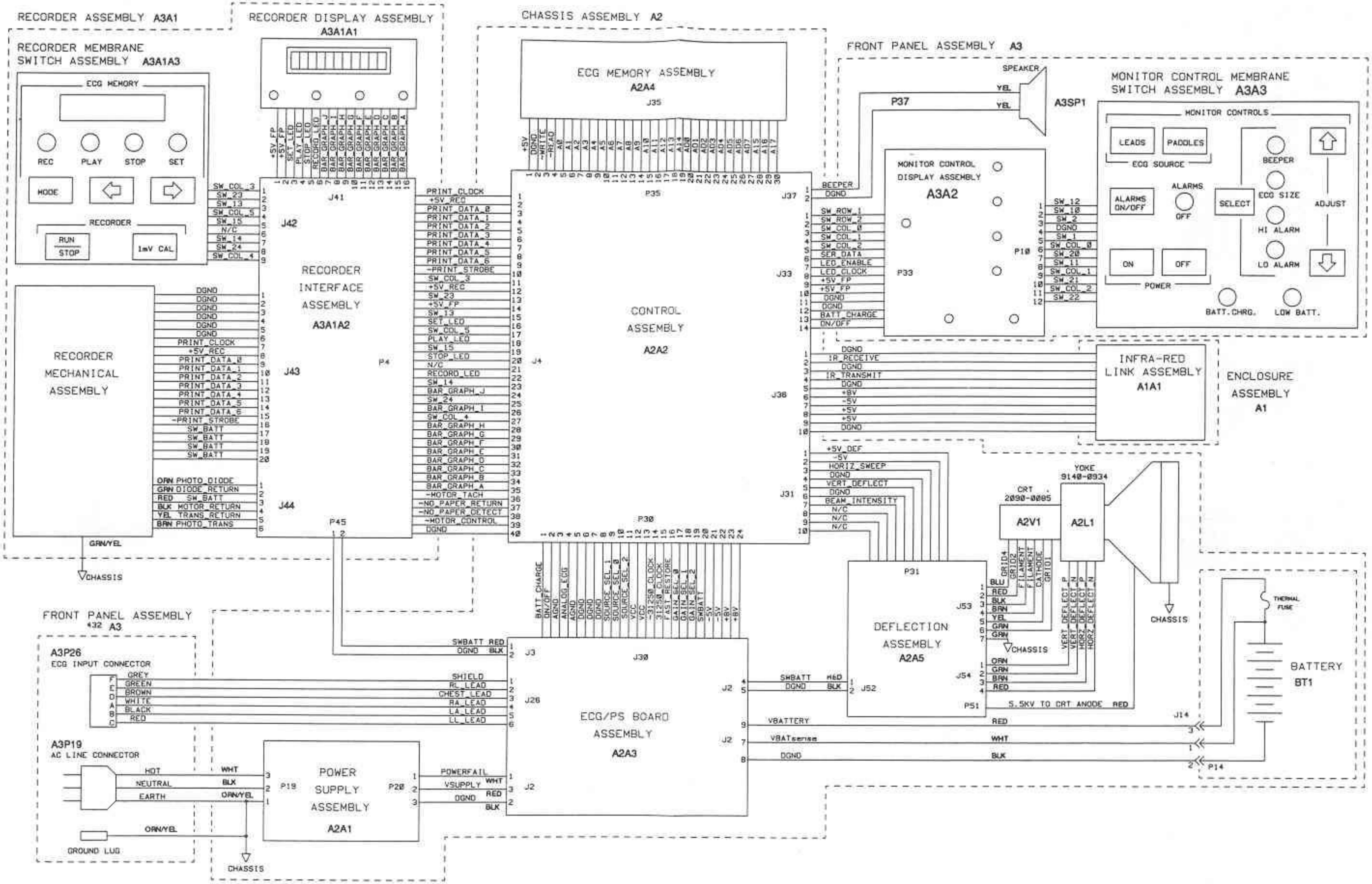

RECORDER ASSEMBLY A3A1
RECORDER DISPLAY ASSEMBLY A3A1A1
RECORDER MEMBRANE SWITCH ASSEMBLY A3A1A3
ECG MEMORY
REC
PLAY
STOP
SET
MODE
RECORDER
RUN STOP
1mV CAL
SW_COL_3
SW_23
SW_13
SW_COL_5
SW_15
N/C
SW_14
SW_24
SW_COL_4
J42
J41
+5V_FP
+5V_FP
SET_LED
PLAY_LED
STOP_LED
RECORD_LED
BAR_GRAPH_J
BAR_GRAPH_I
BAR_GRAPH_H
BAR_GRAPH_G
BAR_GRAPH_F
BAR_GRAPH_E
BAR_GRAPH_D
BAR_GRAPH_C
BAR_GRAPH_B
BAR_GRAPH_A
RECORDER MECHANICAL ASSEMBLY
DGND
PRINT_CLOCK
+5V_REC
PRINT_DATA_0
PRINT_DATA_1
PRINT_DATA_2
PRINT_DATA_3
PRINT_DATA_4
PRINT_DATA_5
PRINT_DATA_6
-PRINT_STROBE
SW_BATT
J43
ORN PHOTO_DIODE
GRN DIODE_RETURN
RED SW_BATT
BLK MOTOR_RETURN
YEL TRANS_RETURN
BRN PHOTO_TRANS
J44
GRN/YEL
CHASSIS
RECORDER INTERFACE ASSEMBLY A3A1A2
P4
P45
J4
SW_COL_3
+5V_REC
SW_23
+5V_FP
SW_13
SET_LED
SW_COL_5
PLAY_LED
SW_15
STOP_LED
N/C
RECORD_LED
SW_14
BAR_GRAPH_J
SW_24
BAR_GRAPH_I
SW_COL_4
BAR_GRAPH_H
BAR_GRAPH_G
BAR_GRAPH_F
BAR_GRAPH_E
BAR_GRAPH_D
BAR_GRAPH_C
BAR_GRAPH_B
BAR_GRAPH_A
-MOTOR_TACH
-NO_PAPER_RETURN
-NO_PAPER_DETECT
-MOTOR_CONTROL
DGND
CHASSIS ASSEMBLY A2
ECG MEMORY ASSEMBLY A2A4
J35
+5V
DGND
-WRITE
-READ
A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12 A13 A14
AD0 AD1 AD2 AD3 AD4 AD5 AD6 AD7 A15 A16 A17
P35
J37
J33
CONTROL ASSEMBLY A2A2
J38
J31
P30
BATT_CHARGE
ON/OFF
AGND
ANALOG_ECG
AGND
DGND
SOURCE_SEL_1
SOURCE_SEL_0
SOURCE_SEL_2
VCC
-31250_CLOCK
31250_CLOCK
FAST_RESTORE
GAIN_SEL_0
GAIN_SEL_1
GAIN_SEL_2
SWBATT
-5V
+8V
FRONT PANEL ASSEMBLY A3
SPEAKER
YEL
YEL
P37
A3SP1
BEEPER
DGND
SW_ROW_1
SW_ROW_2
SW_COL_0
SW_COL_1
SW_COL_2
SER_DATA
LED_ENABLE
LED_CLOCK
+5V_FP
+5V_FP
DGND
DGND
BATT_CHARGE
ON/OFF
MONITOR CONTROL DISPLAY ASSEMBLY A3A2
P33
P10
SW_12
SW_10
SW_2
DGND
SW_1
SW_COL_0
SW_20
SW_11
SW_COL_1
SW_21
SW_COL_2
SW_22
MONITOR CONTROL MEMBRANE SWITCH ASSEMBLY A3A3
MONITOR CONTROLS
LEADS
PADDLES
ECG SOURCE
BEEPER
ALARMS ON/OFF
ALARMS
OFF
SELECT
ECG SIZE
HI ALARM
LO ALARM
ADJUST
ON
OFF
POWER
BATT. CHRG.
LOW BATT.
DGND
IR_RECEIVE
DGND
IR_TRANSMIT
DGND
+8V
-5V
+5V
+5V
DGND
INFRA-RED LINK ASSEMBLY A1A1
ENCLOSURE ASSEMBLY A1
+5V_DEF
-5V
HORIZ_SWEEP
DGND
VERT_DEFLECT
DGND
BEAM_INTENSITY
N/C
CRT 2090-0085
YOKE 9140-0934
A2V1
A2L1
GRID4
GRID2
FILAMENT
FILAMENT
CATHODE
GRID1
VERT_DEFLECT_P
VERT_DEFLECT_N
HORZ_DEFLECT_P
HORZ_DEFLECT_N
CHASSIS
P31
J53
BLU
RED
BLK
BRN
YEL
GRN
GRN
CHASSIS
DEFLECTION ASSEMBLY A2A5
J54
ORN
GRN
BRN
RED
P51
5.5KV TO CRT ANODE RED
J52
SWBATT RED
DGND BLK
THERMAL FUSE
BATTERY BT1
J14
P14
FRONT PANEL ASSEMBLY 432 A3
A3P26
ECG INPUT CONNECTOR
GREY
GREEN
BROWN
WHITE
BLACK
RED
SHIELD
RL_LEAD
CHEST_LEAD
RA_LEAD
LA_LEAD
LL_LEAD
J26
SWBATT RED
DGND BLK
J3
J30
ECG/PS BOARD ASSEMBLY A2A3
J2
VBATTERY RED
VBATsense WHT
DGND BLK
A3P19
AC LINE CONNECTOR
HOT WHT
NEUTRAL BLK
EARTH ORN/YEL
P19
POWER SUPPLY ASSEMBLY A2A1
P20
POWERFAIL
VSUPPLY WHT
DGND RED
BLK
ORN/YEL
GROUND LUG
CHASSIS

Figure 6-1. Monitor-Recorder Module Component Locator and Functional Block/ Wiring Diagram (Sheet 2 of 2).

43201-67311 A1 Monitor Enclosure Assembly
See Figure 6-2 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43201-66540	1	PC ASSY-INFRARED LINK
6-2-1	2360-0113	2	PHMS-6-32X.25 P
6-2-2	43201-67305	1	CASE ASSY
	43201-84504	1	LBL-OUTER CASE

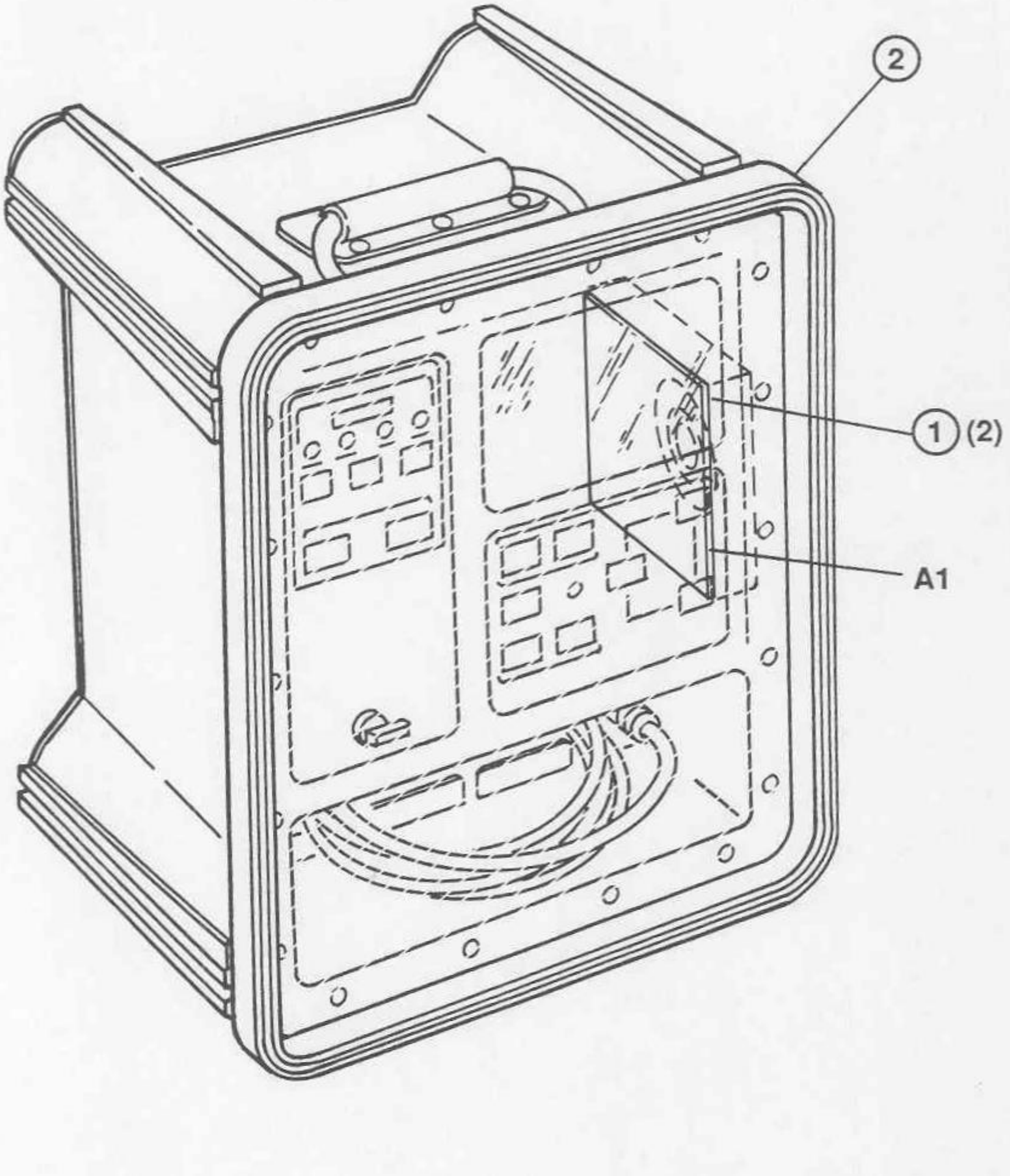
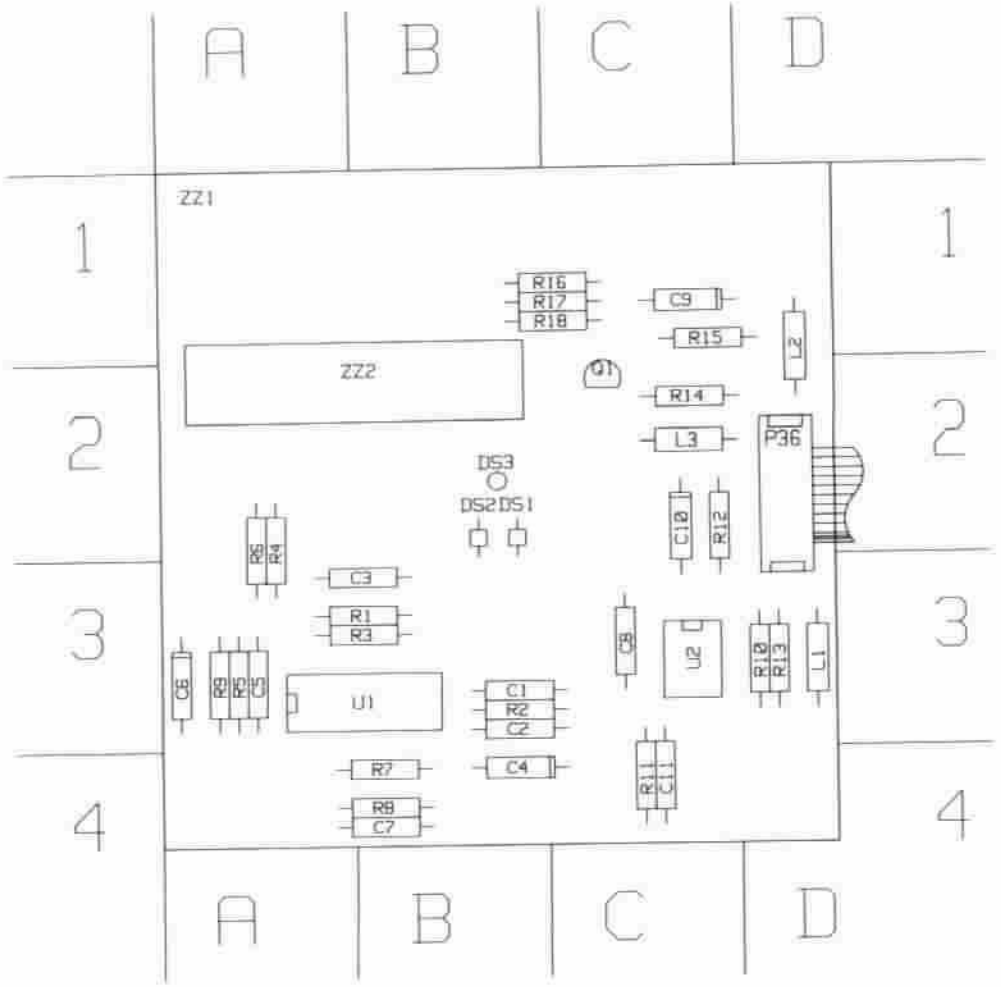


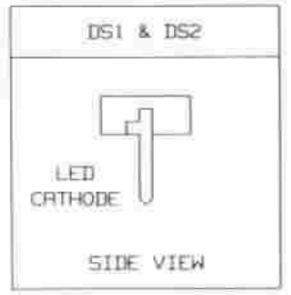
Figure 6-2. A1 Enclosure Assembly Component Locator.

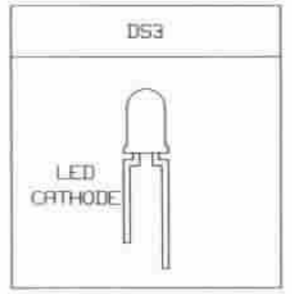
43201-66540 A1A1 Infrared Link Circuit Card Assembly
See Figure 6-3 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
C1,3,7,8,11	0160-4832	5	CAP .01UF 10%
C2,5	0160-4801	2	CAP 100PF 5%
C4,9,10	0180-3551	3	CAP-FIXED 6.8UF
C6	0180-3622	1	CAP-FIXED-ELEC
DS1,2	1990-1291	2	PIN-PHOTODIODE
DS3	1990-1292	1	LED-!R
L1-3	9100-2265	3	INDCTR 10UH 10%
P36	43201-61615	1	CBL ASSY
Q1	1855-0696	1	TRANSISTOR
R1	0757-0447	1	RES-16.2K 1% .12
R2,6,7,10-12	0698-3155	6	RES-4.64K 1% .12
R3,4,8,15	0698-0084	4	RES-2.15K 1% .12
R5,9,13,14,16-18	0698-3438	7	RES 147 1% .125W
U1	1858-0040	1	XSTR ARY 16P-DIP
U2	1826-0412	1	IC 393
ZZ1	43201-86540	1	PC BD-OPTICAL
ZZ2	43201-84704	1	LABEL-BAR CODE

REF DESIG	GRID LOC	PART NUMBER
C1	B3	0160-4832
C10	C2	0180-3551
C11	C4	0160-4832
C2	B3	0160-4801
C3	A3	0160-4832
C4	B4	0180-3551
C5	A3	0160-4801
C6	A3	0180-3622
C7	B4	0160-4832
C8	C3	0160-4832
C9	C1	0180-3551
DS1	B2	1990-1291
DS2	B2	1990-1291
DS3	B2	1990-1292
L1	D3	9100-2265
L2	D2	9100-2265
L3	C2	9100-2265
P36	D2	43201-61615
Q1	C2	1855-0696
R1	A3	0757-0447
R10	D3	0698-3155
R11	C4	0698-3155
R12	C2	0698-3155
R13	D3	0698-3438
R14	C2	0698-3438
R15	C1	0698-0084
R16	B1	0698-3438
R17	B1	0698-3438
R18	B1	0698-3438
R2	B3	0698-3155
R3	A3	0698-0084
R4	A3	0698-0084
R5	A3	0698-3438
R6	A3	0698-3155
R7	B4	0698-3155
R8	B4	0698-0084
R9	A3	0698-3438
U1	A3	1858-0040
U2	C3	1826-0412
ZZ1	A1	43201-86540
ZZ2	A2	43201-84704


A
B
C
D
1
2
3
4
ZZ1
ZZ2
R16
R17
R18
C9
R15
L2
Q1
R14
L3
P36
DS3
DS2
DS1
C10
R12
R6
R4
C3
R1
R3
C6
R9
R5
U1
C1
R2
C2
C8
U2
R10
R13
L1
R7
C4
R8
C7
R11
C11


DS1 & DS2
LED
CATHODE
SIDE VIEW


DS3
LED
CATHODE

PCB	43201-86540	ZZ1
BAR CODE LABEL	43201-84704	ZZ2

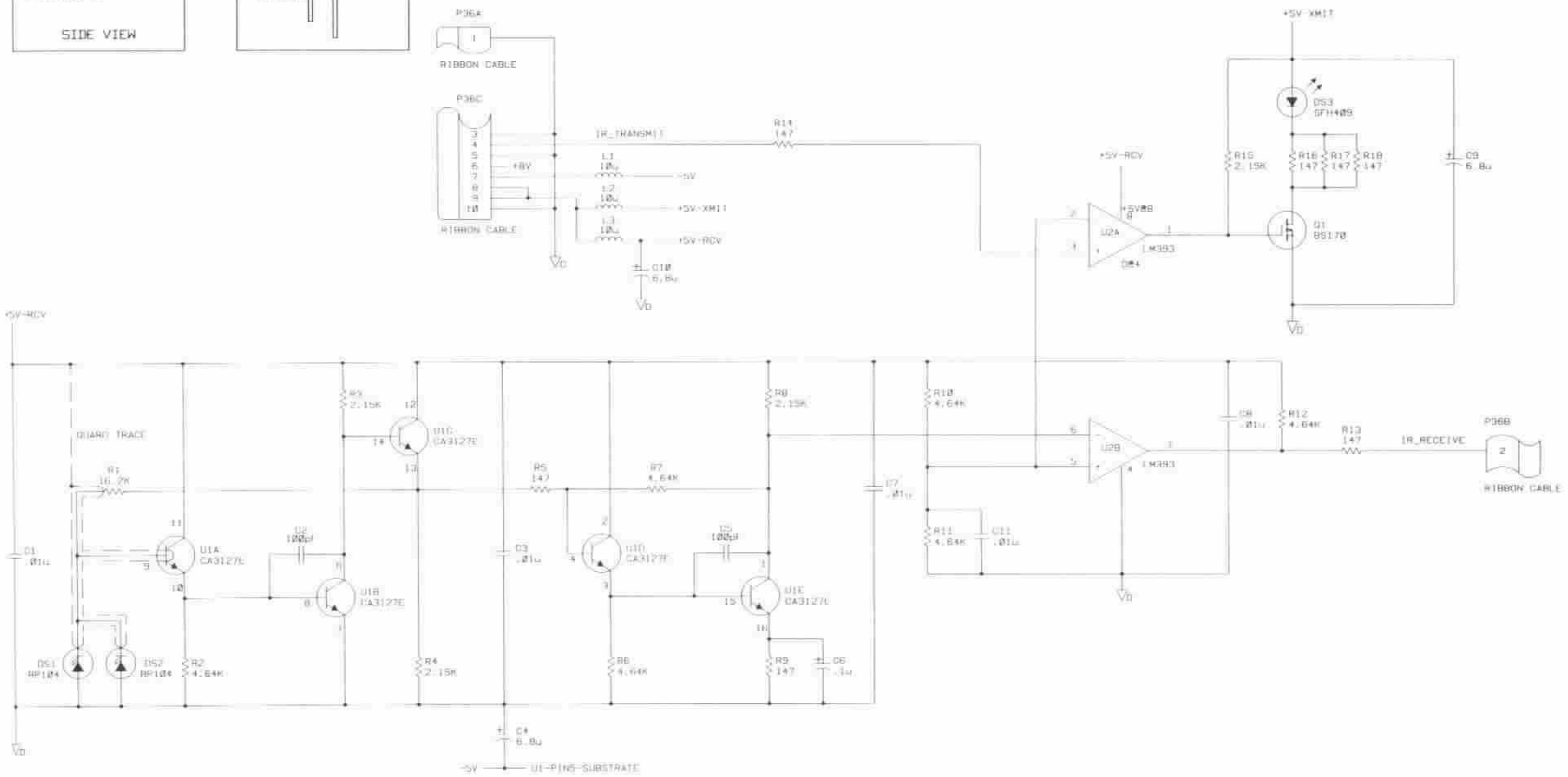

P36A
1
RIBBON CABLE
P36C
3
4
5
6
7
8
9
10
RIBBON CABLE
IR_TRANSMIT
R14
147
+8V
L1
10u
-5V
L2
10u
+5V-XMIT
L3
10u
+5V-RCV
C10
6.8u
+5V XMIT
DS3
SFH409
R15
2.15K
R16
147
R17
147
R18
147
C9
6.8u
+5V-RCV
+5V08
U2A
LM393
Q1
BS170
+5V-RCV
GUARD TRACE
R1
16.2K
C1
.01u
U1A
CA3127E
DS1
BP104
DS2
BP104
R2
4.64K
R3
2.15K
U1C
CA3127E
C2
100pf
U1B
CA3127E
R4
2.15K
C3
.01u
C4
6.8u
-5V
U1-PINS-SUBSTRATE
R5
147
R7
4.64K
U1D
CA3127E
R6
4.64K
C5
100pf
R8
2.15K
U1E
CA3127E
R9
147
C6
.1u
C7
.01u
R10
4.64K
R11
4.64K
C11
.01u
U2B
LM393
C8
.01u
R12
4.64K
R13
147
IR_RECEIVE
P36B
2
RIBBON CABLE

Figure 6-3. A1A1 Infrared Link Circuit Card Assembly Component Locator and Schematic Diagram.

A1A1

43201-67101 A2 Monitor Chassis Assembly
See Figure 6-4 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43201-62700	1	PWR SUPPLY-OEM
A2	43201-66500	1	PC ASSY-MON CONT
A3	43201-66510	1	PC ASSY-MON ECG
A4	43201-66550	1	PC ASSY-MON MEM
A5	43201-66570	1	PC ASSY-CRT DEFL
L1	9140-0934	1	YOKE-DEFLECTION
P20	43201-61600	1	CBL HARN P DIST
P53	43201-61614	1	CBL AY-CRT SKT
V1	2090-0085	1	CRT-5 INCH
6-4-1	0380-2029	8	STANDOFF
6-4-2	0400-0333	4	SHOCK MOUNT
6-4-3	0400-0339	2	GROMMET, RND 1.0
6-4-4	1400-1377	1	CBL CLAMP, RIBN
6-4-5	1400-1526	1	TWIST LOCK TIE
6-4-6	2190-0758	4	WASHER - 8-.5
6-4-7	2360-0113	16	PHMS-6-32X.25 P
6-4-8	2420-0006	1	NUT-HX LK WSHR
6-4-9	1252-2216	1	CLIP CABLE
6-4-10	1252-1502	1	CLIP CABLE
6-4-11	1252-3706	1	CLIP CABLE
6-4-12	43201-07318	1	BRACE, CHASSIS
	43201-67103	1	CHASSIS ASSY
	43201-84501	1	LABEL SET, PAPER

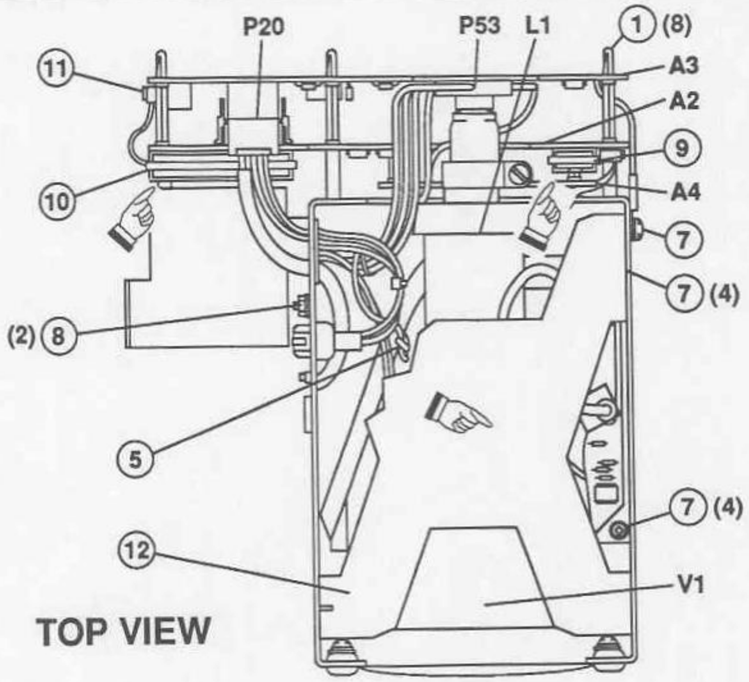
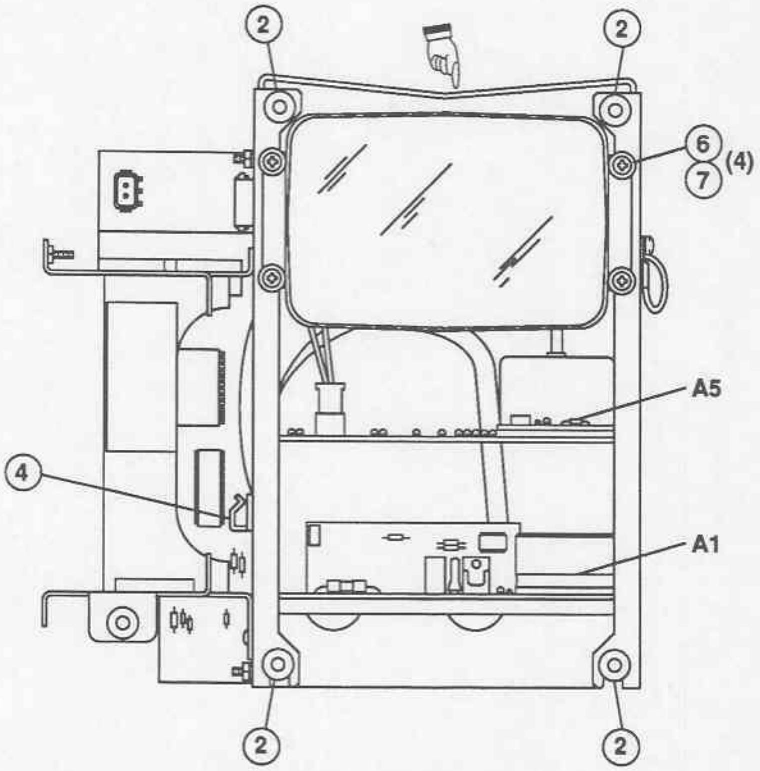


Figure 6-4. A2 Chassis Assembly Component Locator (Sheet 1 of 2).



FRONT VIEW

A2

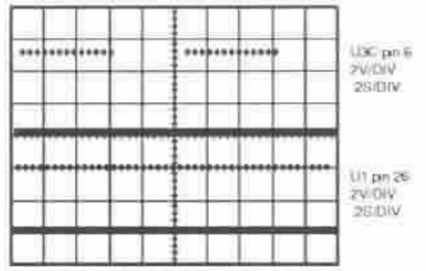
Figure 6-4. A2 Chassis Assembly Component Locator (Sheet 2 of 2).

43201-66500 A2A2 Control Circuit Card Assembly
See Figure 6-5 for Parts Breakdown

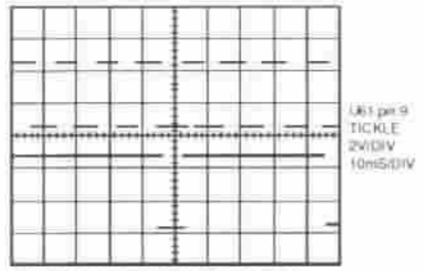
Reference Designator	Part Number	Qty	Description
C2,70,86,109	0180-3552	4	CAP-FIXED 4.7UF
C5,6	0160-3875	2	CAP 22PF 5% 200V
C9,10,16,31-34,37,39,44, C45,61,65,67,69,72,73,95, C108,112	0160-5422	20	CAP .047UF 20%
C12,35,40,43	0160-4801	4	CAP 100PF 5%
C36,82	0160-4830	2	CAP 2200PF 10%
C41,42,68,83-85,89,90,100, C101	0180-3551	10	CAP-FIXED 6.8UF
C71	0180-3422	1	C-F 10UF 10V TA
C80	0160-4832	1	CAP .01UF 10%
C88	0160-6623	1	CAP .1UF 20% 50V
C94	0180-3626	1	C-F .68UF 25V TA
CR1-4,13-15,23,24,31,32	1901-0044	11	DIO-SWITCHING
CR8,33,95	1902-0551	3	DIO-6.19V 5%
CR67-70,78-81	1900-0233	8	DIO-SCHOTTKY
CR91	1906-0312	1	DIODE-MULTIPLE
J4	1251-8158	1	CONN-POST-TP-HDR
J31,36	1252-1920	2	CONN-POST-TP-HDR
J33	1251-8332	1	CONN-POST-TP-HDR
J37	1252-1919	1	CONN-POST-TP-HDR
L1,31,64,66	9100-1788	4	CORE-FERRITE
L30,70	9140-0137	2	COIL-1000UH 5%
L61	9100-2265	1	INDCTR 10UH 10%
P30	43201-61609	1	CBL AY-PS/ECG
P35	1252-3065	1	CONN-POST RECPT
Q1,62	1853-0036	2	XSTR-2N3906
Q2,61	1854-0215	2	XSTR-NPN SI
Q5	1854-0583	1	XSTR NPN SI
R1,82	0683-1065	2	RES 10M 5% .25W
R2	0698-3446	1	RES 383 1% 125W
R3	0757-0274	1	RES-1.21K 1% .12
R4,90,92,93	0698-0084	4	RES-2.15K 1% .12
R5,6,12,16,33,34	0757-0442	6	RES-10K 1% .125
R7,31,35,68,89	0757-0416	5	RES-.511K 1% .12
R8	0698-3155	1	RES-4.64K 1% .12
R10,76	0698-3458	2	RES-348K 1% .125
R11,17-21, 26,27	0757-0280	8	RES-1K 1% .125W
R13,14	0698-8827	2	RESISTOR 1M
R15,32	0698-3158	2	RES-23.7K 1% .12
R22,128,129	1810-0922	3	NETWORK-RES SIP
R37	0757-0290	1	RES-6.19K 1% .12
R73	0698-3453	1	RES-196K 1% .125
R74	757-0465	1	RES-100K 1% .125
R75,102	0757-0462	2	RES-75K 1% .125W
R78,104,105	0698-3157	3	RES 19.6K

43201-66500 A2A2 Control Circuit Card Assembly (Continued)
See Figure 6-5 for Parts Breakdown

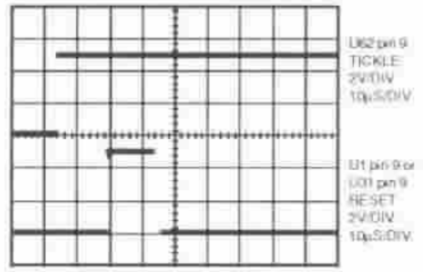
Reference Designator	Part Number	Qty	Description
R91	0757-0278	1	RES-1.78K 1% .12
R99-101	0698-3451	3	RES-133K 1% .125
R103	0698-6942	1	RES 25K .1%
R106	0698-7933	1	RES 3.83 .1%
R107	0699-0847	1	RES 1.96 .1%
R111	1810-0269	1	NETWORK-RES SIP
U1	1820-6417	1	MASK PROG-80C51
U2	1820-3082	1	IC MC74HC374N
U3	1820-3008	1	IC MM74HCUO4N
U4	1820-3081	1	IC-MC74HC74N
U5	1820-3297	1	IC-MC74HC244N
U6	1820-3674	1	IC-MC74HC125N
U7,65	1826-0521	2	IC-072
U10,11	1820-3344	2	IC-MC74HC595N
U12,13	1820-2254	2	IC-INTERFACE
U31	1820-6418	1	MASK PROG80C51FA
U33	1820-5297	1	ASIC-COS-G-ARRAY
U34	1820-1934	1	D/A 8-BIT
U35	1826-1286	1	OP AMP DUAL CMOS
U61	1820-6419	1	MASK PROG80C51FA
U62	1820-5298	1	ASIC-COS-G-ARRAY
U63	1826-1248	1	IC-CONVERTER
U64	1820-1545	1	IC 4053B
U66	1820-2921	1	IC MM74HCO4N
U67	1826-0718	1	IC MC1404U5
U69	1826-0276	1	IC MC78L05ACP
X1,31,61	5081-9529	3	IC SOCKET
Y1	0410-1558	1	XTAL 12.00 MHZ
ZZ1	43201-86500	1	PC BD-MON CONT
ZZ2	43201-84700	1	LABEL-BAR CODE



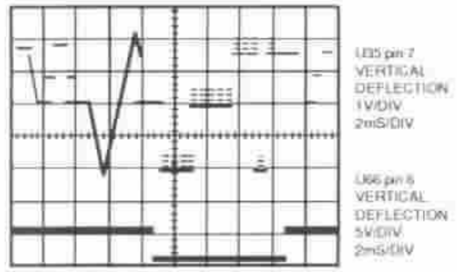
RECORDER RUNNING, SMALL ROLL OF PAPER



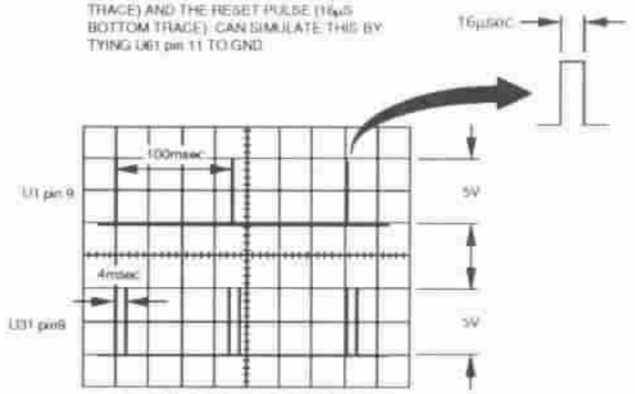
IF U61 FAILS TO TICKLE U62, THE RESET SIGNAL (CONRST) TO U61-9 MAY LOOK LIKE EITHER OF THESE



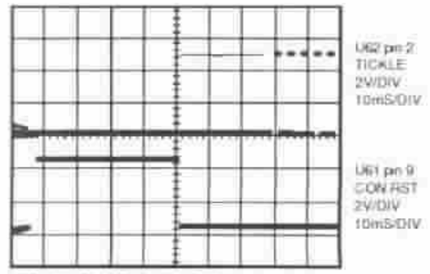
SLAVE PROCESSOR (U1 OR U31) NOT RESPONDING. THIS ILLUSTRATION SHOWS RELATIONSHIP BETWEEN TICKLE (TOP TRACE) AND THE RESET PULSE (16µS BOTTOM TRACE). CAN SIMULATE THIS BY TYING U61 pin 11 TO GND



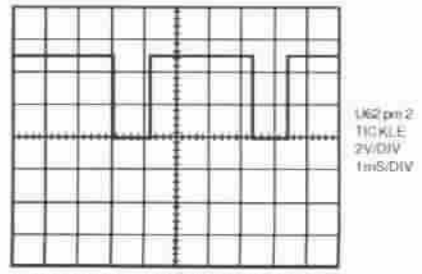
IN SERVICE MODE (REFER TO PARAGRAPH 5-3)



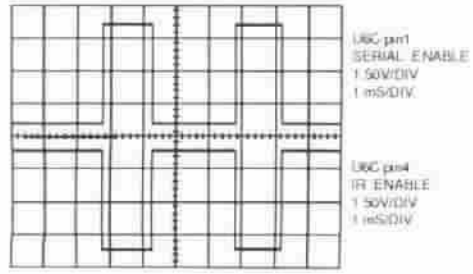
RESET SIGNALS TO U1 AND/OR U31 IF THEY DON'T RESPOND TO U61. CAN SIMULATE THIS BY TYING U61 pin 11 TO GND



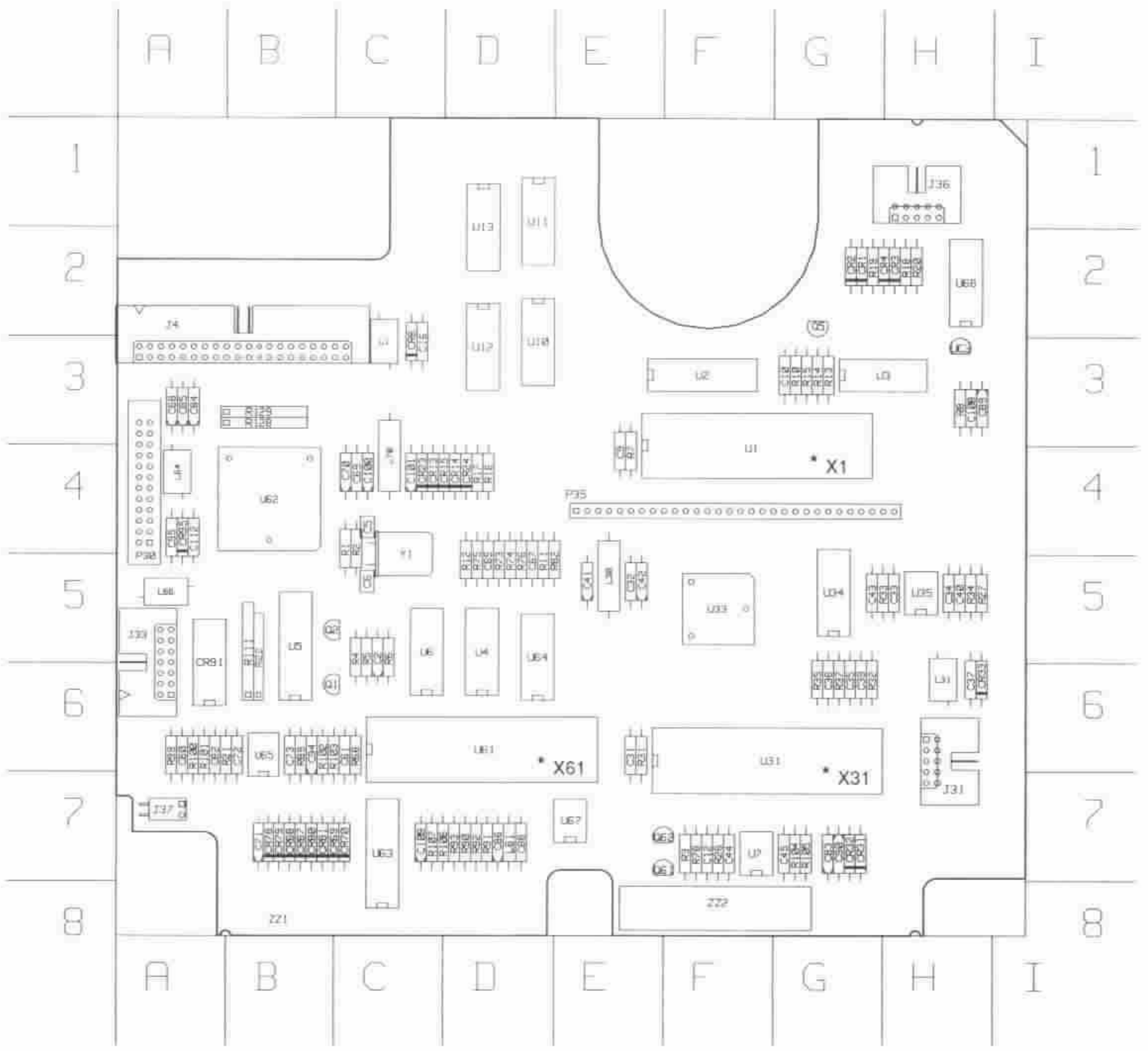
SEQUENCE OF EVENTS AT TURN ON. EXT TRIGGERED ON ON/OFF.



U61 OPERATING UNDER NORMAL CONDITIONS SOFTWARE IS EXECUTED WHILE SIGNAL IS HIGH



REF DESIG	GRID LOC	PART NUMBER	REF DESIG	GRID LOC	PART NUMBER	REF DESIG	GRID LOC	PART NUMBER
C10	G3	0160-5422	CR4	H2	1901-0044	R26	F7	0757-0280
C100	C4	0180-3551	CR8	C3	1902-0551	R27	H5	0757-0280
C101	C4	0180-3551	CR67	B7	1900-0233	R3	F7	0757-0274
C108	H3	0160-5422	CR68	B7	1900-0233	R31	E6	0757-0416
C109	C7	0180-3552	CR69	C7	1900-0233	R32	G6	0698-3158
C112	A4	0160-5422	CR70	C7	1900-0233	R33	H5	0757-0442
C12	F7	0160-4801	CR78	B7	1900-0233	R34	H5	0757-0442
C16	C3	0160-5422	CR79	B7	1900-0233	R35	G6	0757-0416
C2	C6	0180-3552	CR80	B7	1900-0233	R37	G6	0757-0290
C31	E6	0160-5422	CR81	B7	1900-0233	R4	C6	0698-0084
C32	E5	0160-5422	CR91	A6	1906-0312	R5	C6	0757-0442
C33	H5	0160-5422	CR95	A4	1902-0551	R6	C6	0757-0442
C34	H5	0160-5422	J31	H7	1252-1920	R68	C6	0757-0416
C35	G6	0160-4801	J33	A5	1251-8332	R7	E4	0757-0416
C36	G6	0160-4830	J36	H1	1252-1920	R73	D5	0698-3453
C37	H6	0160-5422	J37	A7	1252-1919	R74	D5	0757-0465
C39	G6	0160-5422	J4	A2	1251-8158	R75	D5	0757-0462
C40	H5	0160-4801	L1	C3	9100-1788	R76	D5	0698-3458
C41	E5	0180-3551	L30	E5	9140-0137	R78	F7	0698-3157
C42	E5	0180-3551	L31	H6	9100-1788	R8	H3	0698-3155
C43	G5	0160-4801	L61	D7	9100-2265	R82	E5	0683-1065
C44	F7	0160-5422	L64	A4	9100-1788	R89	B6	0757-0416
C45	G7	0160-5422	L66	A5	9100-1788	R90	D7	0698-0084
C5	C4	0160-3875	L70	C4	9140-0137	R91	D7	0757-0278
C6	C5	0160-3875	P30	A5	43201-61609	R92	D7	0698-0084
C61	C6	0160-5422	P35	E4	1252-3065	R93	D7	0698-0084
C65	D5	0160-5422	Q1	B6	1853-0036	R99	A6	0698-3451
C67	D5	0160-5422	Q2	B5	1854-0215	U1	F4	1820-6417
C68	A3	0180-3551	Q5	G2	1854-0583	U10	D3	1820-3344
C69	C4	0160-5422	Q61	E7	1854-0215	U11	D1	1820-3344
C70	C4	0180-3552	Q62	E7	1853-0036	U12	D3	1820-2254
C71	B7	0180-3422	R1	C5	0683-1065	U13	D2	1820-2254
C72	B6	0160-5422	R10	G3	0698-3458	U2	F3	1820-3082
C73	B6	0160-5422	R100	A6	0698-3451	U3	G3	1820-3008
C80	A6	0160-4832	R101	A6	0698-3451	U31	F6	1820-6418
C82	A6	0160-4830	R102	B6	0757-0462	U33	F5	1820-5297
C83	G7	0180-3551	R103	C6	0698-6942	U34	G5	1820-1934
C84	A3	0180-3551	R104	G7	0698-3157	U35	H5	1826-1286
C85	A3	0180-3551	R105	G7	0698-3157	U4	D5	1820-3081
C86	D7	0180-3552	R106	D7	0698-7933	U5	B5	1820-3297
C88	D7	0160-6623	R107	C7	0699-0847	U6	C5	1820-3674
C89	H3	0180-3551	R11	D5	0757-0280	U61	D6	1820-6419
C9	E4	0160-5422	R111	B6	1810-0269	U62	B4	1820-5298
C90	G7	0180-3551	R12	D5	0757-0442	U63	C7	1826-1248
C94	B6	0180-3626	R128	B3	1810-0922	U64	D5	1820-1545
C95	A4	0160-5422	R129	B3	1810-0922	U65	B6	1826-0521
CR1	G2	1901-0044	R13	G3	0698-8827	U66	H2	1820-2921
CR13	C4	1901-0044	R14	G3	0698-8827	U67	E7	1826-0718
CR14	D4	1901-0044	R15	G3	0698-3158	U69	H3	1826-0276
CR15	D4	1901-0044	R16	D4	0757-0442	U7	F7	1826-0521
CR2	G2	1901-0044	R17	D4	0757-0280	Y1	C5	0410-1558
CR23	C4	1901-0044	R18	H2	0757-0280	ZZ1	B8	43201-86500
CR24	D4	1901-0044	R19	G2	0757-0280	ZZ2	F8	43201-84700
CR3	H2	1901-0044	R2	C5	0698-3446	* X1	F4	5081-9529
CR31	G7	1901-0044	R20	H2	0757-0280	* X31	F6	5081-9529
CR32	G7	1901-0044	R21	B6	0757-0280	* X61	D6	5081-9529
CR33	H6	1902-0551	R22	B6	1810-0922			



* X1, X31, AND X61 ONLY USED ON PREFIX 2942A.

Figure 6-5. A2A2 Control Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 1 of 4).

A2A2

REV E0390-2 6-21/22

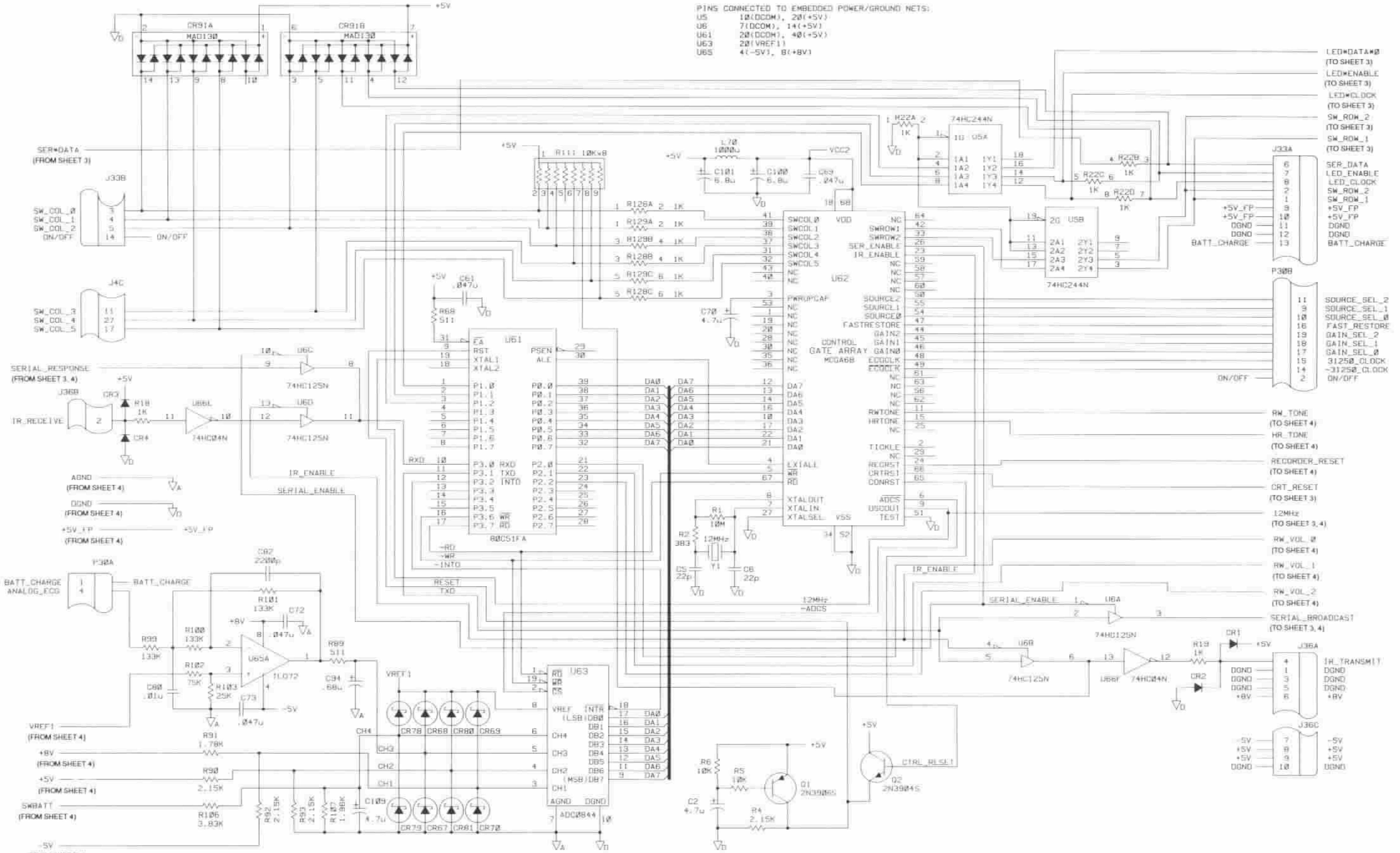
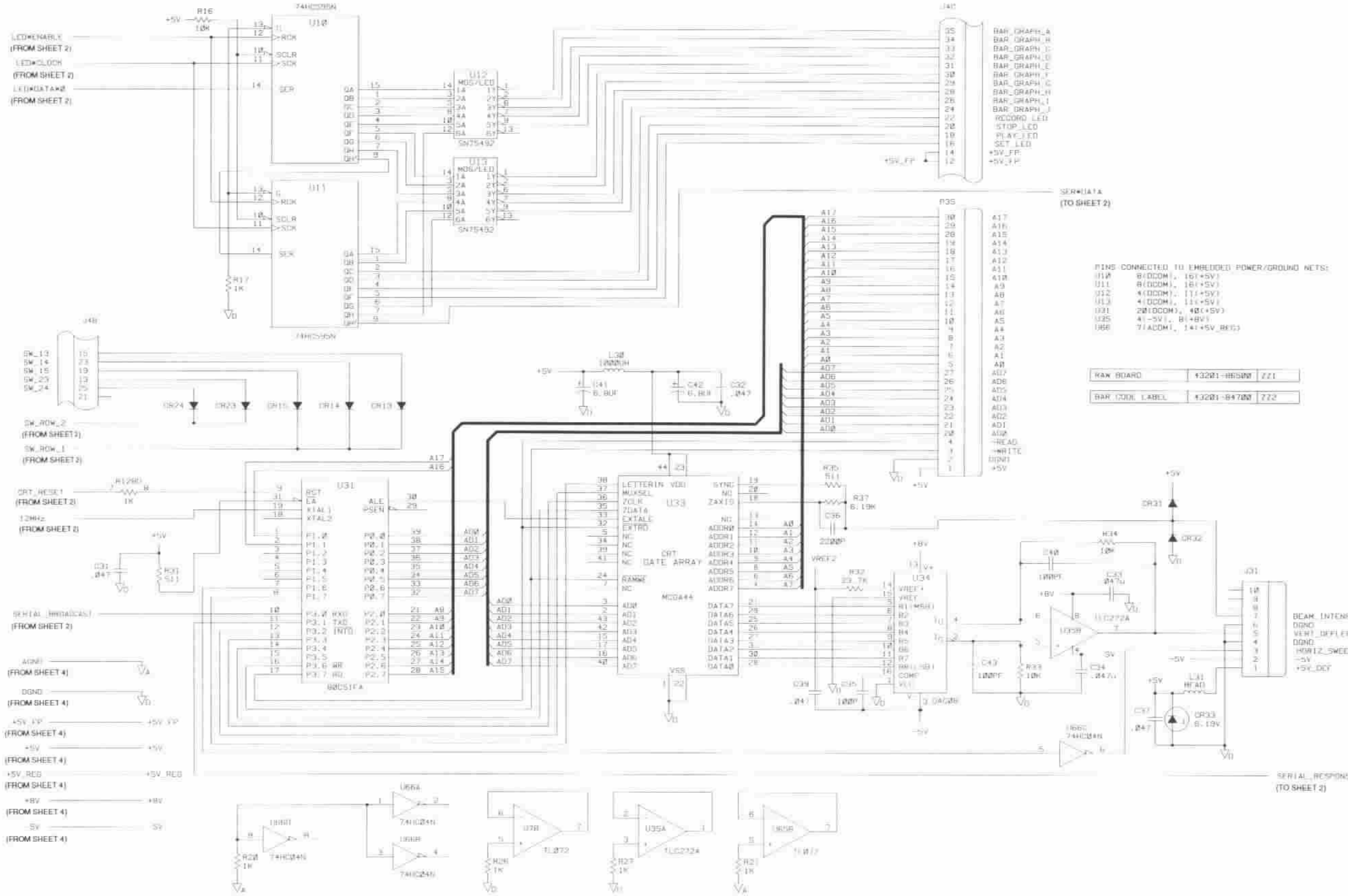

PINS CONNECTED TO EMBEDDED POWER/GROUND NETS:
U5 10(DCOM), 20(+5V)
U6 7(DCOM), 14(+5V)
U61 20(DCOM), 40(+5V)
U63 20(VREF1)
U65 4(-5V), 8(+8V)
+5V
CR91A MAD130
CR91B MAD130
SER*DATA (FROM SHEET 3)
J33B
SW_COL_0
SW_COL_1
SW_COL_2
ON/OFF
J4C
SW_COL_3
SW_COL_4
SW_COL_5
SERIAL_RESPONSE (FROM SHEET 3, 4)
U6C
74HC125N
J36B
CR3
R18 1K
U66L
74HC04N
U6D
74HC125N
IR_RECEIVE
CR4
IR_ENABLE
SERIAL_ENABLE
AGND (FROM SHEET 4)
DGND (FROM SHEET 4)
+5V_FP (FROM SHEET 4)
+5V_FP
P30A
BATT_CHARGE
ANALOG_ECG
BATT_CHARGE
C82 2200p
R101 133K
C72 .047u
+8V
R99 133K
R100 133K
U65A
TL072
R102 75K
R103 25K
C80 .01u
C73 .047u
-5V
R89 511
C94 .68u
VREF1
VREF1 (FROM SHEET 4)
+8V (FROM SHEET 4)
+5V (FROM SHEET 4)
SWBATT (FROM SHEET 4)
-5V (FROM SHEET 4)
R91 1.78K
R90 2.15K
R106 3.83K
R92 2.15K
R93 2.15K
R107 1.38K
C109 4.7u
CH4
CH3
CH2
CH1
CR78
CR68
CR80
CR69
CR79
CR67
CR81
CR70
R111 10Kx8
+5V
C61 .047u
R68 511
U61
80C51FA
EA
RST
XTAL1
XTAL2
PSEN
ALE
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P3.0 RXD
P3.1 TXD
P3.2 INT0
P3.3
P3.4
P3.5
P3.6 WR
P3.7 RD
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
RXD
-RD
-WR
-INT0
RESET
TXD
DA0
DA1
DA2
DA3
DA4
DA5
DA6
DA7
R126A 1K
R129A 1K
R129B 1K
R128B 1K
R129C 1K
R128C 1K
L70 1000u
C101 6.8u
C100 6.8u
C69 .047u
VCC2
C70 4.7u
U62
CONTROL GATE ARRAY MC0A6B
SWCOL0
SWCOL1
SWCOL2
SWCOL3
SWCOL4
SWCOL5
VDD
PWRUPCAP
SWROW1
SWROW2
SER_ENABLE
IR_ENABLE
SOURCE2
SOURCE1
SOURCE0
FASTRESTORE
GAIN2
GAIN1
GAIN0
ECOCLK
ECOCLK
RWTONE
HRTONE
TICKLE
RECRST
CRTRST
CONRST
ADCS
USCOUT
TEST
EXTALL
WR
RD
XTALOUT
XTALIN
XTALSEL
VSS
NC
R1 10M
R2 383
12MHz
Y1
C5 22p
C6 22p
12MHz
-ADCS
IR_ENABLE
SERIAL_ENABLE
U6A
74HC125N
U63
ADC0844
RD
WR
CS
VREF
INTR
(LSB)DB0
DB1
DB2
DB3
DB4
DB5
DB6
(MSB)DB7
AGND
DGND
+5V
R6 10K
R5 10K
Q1 2N3906S
C2 4.7u
R4 2.15K
Q2 2N3904S
CTRL_RESET
U6B
74HC125N
U66F 74HC04N
R19 1K
CR1
CR2
74HC244N
U5A
R22A 1K
1G
1A1
1A2
1A3
1A4
1Y1
1Y2
1Y3
1Y4
U5B
2G
2A1
2A2
2A3
2A4
2Y1
2Y2
2Y3
2Y4
R22B 1K
R22C 1K
R22D 1K
LED*DATA*0 (TO SHEET 3)
LED*ENABLE (TO SHEET 3)
LED*CLOCK (TO SHEET 3)
SW_ROW_2 (TO SHEET 3)
SW_ROW_1 (TO SHEET 3)
J33A
SER_DATA
LED_ENABLE
LED_CLOCK
SW_ROW_2
SW_ROW_1
+5V_FP
+5V_FP
DGND
DGND
BATT_CHARGE
P30B
SOURCE_SEL_2
SOURCE_SEL_1
SOURCE_SEL_0
FAST_RESTORE
GAIN_SEL_2
GAIN_SEL_1
GAIN_SEL_0
31250_CLOCK
~31250_CLOCK
ON/OFF
RW_TONE (TO SHEET 4)
HR_TONE (TO SHEET 4)
RECORDER_RESET (TO SHEET 4)
CRT_RESET (TO SHEET 3)
12MHz (TO SHEET 3, 4)
RW_VOL_0 (TO SHEET 4)
RW_VOL_1 (TO SHEET 4)
RW_VOL_2 (TO SHEET 4)
SERIAL_BROADCAST (TO SHEET 3, 4)
J36A
IR_TRANSMIT
DGND
DGND
DGND
+8V
J36C
-5V
+5V
+5V
DGND

Figure 6-5. A2A2 Control Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 2 of 4).

A2A2


LED*ENABLE
(FROM SHEET 2)
LED*CLOCK
(FROM SHEET 2)
LED*DATA*0
(FROM SHEET 2)
R16
10K
+5V
74HC595N
U10
U11
RCK
SCLR
SCK
SER
QA
QB
QC
QD
QE
QF
QG
QH
QH'
R17
1K
U12
U13
MOS/LED
SN75492
J40
BAR_GRAPH_A
BAR_GRAPH_B
BAR_GRAPH_C
BAR_GRAPH_D
BAR_GRAPH_E
BAR_GRAPH_F
BAR_GRAPH_G
BAR_GRAPH_H
BAR_GRAPH_I
BAR_GRAPH_J
RECORD_LED
STOP_LED
PLAY_LED
SET_LED
+5V_FP
SER*DATA
(TO SHEET 2)
P35
J48
SW_13
SW_14
SW_15
SW_23
SW_24
CR24
CR23
CR15
CR14
CR13
SW_ROW_2
(FROM SHEET 2)
SW_ROW_1
(FROM SHEET 2)
L30
1000UH
C41
6.8UF
C42
6.8UF
C32
.047
CRT_RESET
(FROM SHEET 2)
R128
1K
12MHz
(FROM SHEET 2)
C31
.047
R31
511
U31
80C51FA
RST
EA
XTAL1
XTAL2
ALE
PSEN
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P3.0 RXD
P3.1 TXD
P3.2 INT0
P3.3
P3.4
P3.5
P3.6 WR
P3.7 RD
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
SERIAL_BROADCAST
(FROM SHEET 2)
AGND
(FROM SHEET 4)
DGND
(FROM SHEET 4)
+5V_FP
(FROM SHEET 4)
+5V
(FROM SHEET 4)
+5V_REG
(FROM SHEET 4)
+8V
(FROM SHEET 4)
-5V
(FROM SHEET 4)
U33
CRT GATE ARRAY
MCD444
LETTERIN
MUXSEL
7CLK
7DATA
EXTALE
EXTRD
RAMWE
SYNC
ZAXIS
ADDR0
ADDR1
ADDR2
ADDR3
ADDR4
ADDR5
ADDR6
ADDR7
DATA0
DATA1
DATA2
DATA3
DATA4
DATA5
DATA6
DATA7
VSS
VDD
R35
511
R37
6.19K
C36
2200P
VREF2
R32
23.7K
U34
VREF+
VREF-
B1(MSB)
B2
B3
B4
B5
B6
B7
B8(LSB)
COMP
VLC
DAC08
C39
.047
C35
100P
C40
100PF
R34
10K
C33
.047U
U35B
TLC272A
C43
100PF
R33
10K
C34
.047U
CR31
CR32
L31
MFAD
C37
.047
CR33
6.19V
U86C
74HC04N
J31
BEAM_INTENSITY
DGND
VERT_DEFLECT
DGND
HORIZ_SWEEP
-5V
+5V_DEF
SERIAL_RESPONSE
(TO SHEET 2)
U86A
U86B
U86D
74HC04N
R20
1K
U7B
TL072
R26
1K
U35A
TLC272A
R27
1K
U85B
TL072
R21
1K

PINS CONNECTED TO EMBEDDED POWER/GROUND NETS:

U10	8(DCOM), 16(+5V)
U11	8(DCOM), 16(+5V)
U12	4(DCOM), 11(+5V)
U13	4(DCOM), 11(+5V)
U31	20(DCOM), 40(+5V)
U35	4(-5V), 8(+8V)
U86	7(ACOM), 14(+5V_REG)

RAW BOARD	43201-86500	ZZ1
BAR CODE LABEL	43201-84700	ZZ2

Figure 6-5. A2A2 Control Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 3 of 4).

PINS CONNECTED TO EMBEDDED POWER/GROUND NETS:

U1	20(DCOM), 40(+5V)
U2	10(DCOM), 20(+5V)
U3	7(DCOM), 14(+5V)
U4	7(DCOM), 14(+5V)
U64	7(-5V), 8(DCOM), 16(+5V)
U7	4(-5V), 8(+8V)

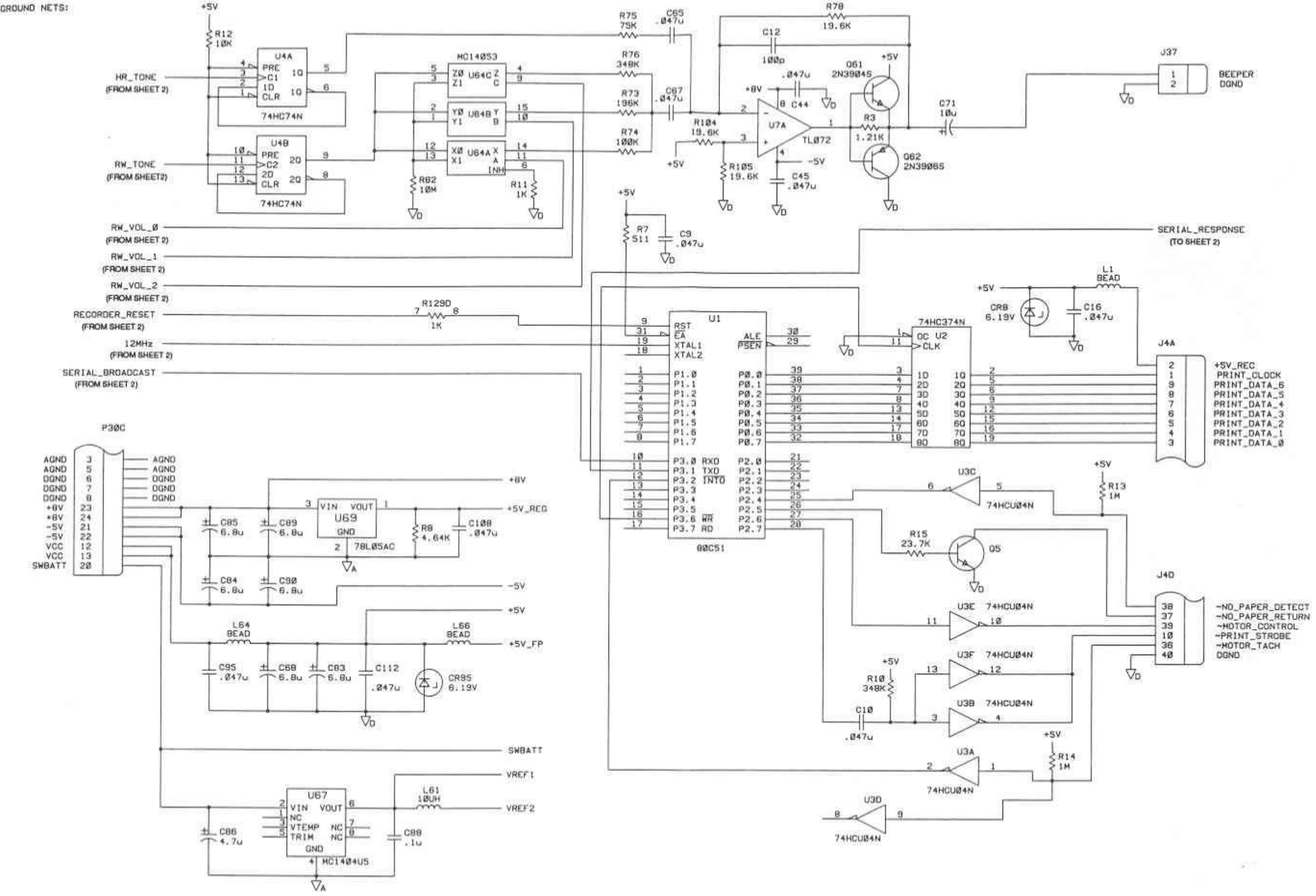

HR_TONE (FROM SHEET 2)
RW_TONE (FROM SHEET2)
RW_VOL_0 (FROM SHEET 2)
RW_VOL_1 (FROM SHEET 2)
RW_VOL_2 (FROM SHEET 2)
RECORDER_RESET (FROM SHEET 2)
12MHz (FROM SHEET 2)
SERIAL_BROADCAST (FROM SHEET 2)
SERIAL_RESPONSE (TO SHEET 2)
U4A 74HC74N
U4B 74HC74N
MC14053 U64C U64B U64A
R12 10K
R82 10M
R11 1K
R75 75K
R76 348K
R73 196K
R74 100K
C65 .047u
C67 .047u
C12 100p
R78 19.6K
R104 19.6K
R105 19.6K
C44 .047u
C45 .047u
U7A TL072
Q61 2N3904S
Q62 2N3906S
R3 1.21K
C71 10u
J37
BEEPER
DGND
R7 511
C9 .047u
R129D 1K
U1 80C51
RST EA XTAL1 XTAL2 ALE PSEN
P1.0 P1.1 P1.2 P1.3 P1.4 P1.5 P1.6 P1.7
P0.0 P0.1 P0.2 P0.3 P0.4 P0.5 P0.6 P0.7
P3.0 RXD P3.1 TXD P3.2 INT0 P3.3 P3.4 P3.5 P3.6 WR P3.7 RD
P2.0 P2.1 P2.2 P2.3 P2.4 P2.5 P2.6 P2.7
74HC374N U2
L1 BEAD
CR8 6.19V
C16 .047u
J4A
+5V_REC
PRINT_CLOCK
PRINT_DATA_6
PRINT_DATA_5
PRINT_DATA_4
PRINT_DATA_3
PRINT_DATA_2
PRINT_DATA_1
PRINT_DATA_0
U3C 74HCU04N
R13 1M
R15 23.7K
Q5
J4D
~NO_PAPER_DETECT
~NO_PAPER_RETURN
~MOTOR_CONTROL
~PRINT_STROBE
~MOTOR_TACH
DGND
U3E 74HCU04N
U3F 74HCU04N
U3B 74HCU04N
U3A 74HCU04N
U3D 74HCU04N
R10 348K
C10 .047u
R14 1M
P30C
AGND AGND DGND DGND DGND +8V +8V -5V -5V VCC VCC SWBATT
U69 78L05AC
C85 6.8u
C89 6.8u
C84 6.8u
C90 6.8u
R8 4.64K
C108 .047u
+8V
+5V_REG
-5V
+5V
+5V_FP
L64 BEAD
L66 BEAD
C95 .047u
C68 6.8u
C83 6.8u
C112 .047u
CR95 6.19V
SWBATT
VREF1
VREF2
U67 MC1404U5
VIN VOUT NC VTEMP TRIM GND
L61 10UH
C86 4.7u
C88 .1u

Figure 6-5. A2A2 Control Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 4 of 4).

43201-66510 A2A3 ECG/Power Supply Circuit Card Assembly
See Figure 6-6 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
C101	0160-4832	1	CAP .01UF 10%
C102,104,301	0160-6623	3	CAP .1UF 20% 50V
C103,108,111	0180-3552	3	CAP-FIXED 4.7UF
C105,112	0180-3422	2	C-F 10UF 10V TA
C106,206,303,304	0160-4574	4	CAP 1000PF 10%
C107,110	0180-3553	2	CAP-FIXED 3.3UF
C109	0160-4846	1	CAP 1500PF 5%
C113	0180-4127	1	CAPACITOR-ALUM
C201-205	0160-4801	5	CAP 100PF 5%
C207	0160-5422	1	CAP .047UF 20%
C208,209,305-307	0180-3551	5	CAP-FIXED 6.8UF
C302	0160-7035	1	CAP 2NT-10%
CR101	1902-3094	1	DIO-ZNR 5.11V 2%
CR102	1902-0969	1	DIO-ZNR 30V 5%
CR103-105,107-109	1901-0620	6	DIO-SWITCHING
CR106	1901-0937	1	DIODE, SCHOTTKY
CR110	0837-0193	1	SUPPRESS-VOLTAGE
CR201-218,301-304	1901-0044	22	DIO-SWITCHING
CR305,306	1902-0783	2	DIO-ZNR 16V 5%
DS201-205	2140-0024	5	LAMP-A3C
E201	1970-0209	1	SPARK GAP 4.5kV
E202,203	0837-0196	2	V SUPPR
F101	2110-0010	1	FUSE 5A 250V
FH101	2110-0643	1	FUHLR-CLIP TYPE
J2	1251-5829	1	CONN-9 PIN M
J3	1251-3659	1	CONN UTIL
J26	1251-7557	1	CONN-POST-TP-HDR
J30	1252-2403	1	CONN-POST-TP-HDR
K101,102	0490-1696	2	RELAY 10A 30VDC
L101	9140-0983	1	INDUCTOR
L301	9100-2265	1	INDCTR 10UH 10%
MP101	1205-0634	1	HEAT SINK
P5	43201-61612	1	WIRE ASY-ECG/ESD
Q101,302	1855-0696	2	TRANSISTOR
Q102	1853-0036	1	XSTR-2N3906
Q103	1853-0058	1	XSTR-2N3644
Q301	1855-0437	1	TRANSISTOR JFET
Q303,304	1854-0210	2	XSTR-NPN 2N2222
R101-104	0698-3446	4	RES 383 1% 125W
R105	0698-7933	1	RES 3.83 .1%
R106,123	0699-0847	2	RES 1.96 .1%
R107,108,118	0757-0280	3	RES-1K 1% .125W
R109,304,305,307	0698-8827	4	RESISTOR 1M
R110,116,117,221-231,235, R236,239,241,301,302,313, R322	0757-0442	22	RES-10K 1% .125
R111	0698-8137	1	RES 9M 1% .125W

43201-66510 A2A3 ECG/Power Supply Circuit Card Assembly (Continued)
See Figure 6-6 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
R112,115	0698-3458	2	RES-348K 1% .125
R113	0683-4745	1	RES 470K 5% .25W
R114	0698-8958	1	RESISTOR 511K
R119	0698-8695	1	RES 36K .1% .125
R120,126,314	0698-6343	3	RES 9K .1% .125W
R121	0698-3266	1	RES-237K 1% .125
R122,237,238	0698-3441	3	RES 215 1% .125W
R124	0757-0200	1	RES-5.62K 1% .12
R125	0811-3605	1	RES .1 5% .5W PW
R127	0698-6348	1	RES-3K .1% .125W
R128	0757-0467	1	RES-121K 1% .125
R129	0683-1815	1	RES 180 5% .25W
R130	0698-4455	1	RES 536 1% .125W
R201,202,219,220,232,234, R240,242-244,306,321	0757-0465	12	RES-100K 1% .125
R203,204,206,207,209, R210,212,213,215-218	0698-3920	12	RES 10K 5% .25W
R205,208,211,214	0683-1065	4	RES 10M 5% .25W
R233	0698-6942	1	RES 25K .1%
R245,246	0699-1993	2	RES-HV 33MEG 5%
R303	0698-3159	1	RES-26.1K 1% .12
R308	2100-3353	1	RES-TRMR 20K 10%
R309	0698-3260	1	RES 464K 1% .125
R310	0757-0439	1	RES 6.81K 1%
R311	2100-3273	1	RES-TRNR 2K 10%
R312,316	0698-3158	2	RES-23.7K 1% .12
R315	0698-3136	1	RES 17.8K 1%
R317	0757-0447	1	RES-16.2K 1% .12
R318	0698-3160	1	RES-31.6K 1% .12
R319,320	0757-0123	2	RES-34.8K 1% .12
R323-327	0698-3154	5	RES-4.22K 1% .12
T201	43100-82730	1	XFMR, SIGNAL
T202	43100-82720	1	XFMR, PWR
U101	1826-0412	1	IC 393
U102	1826-1258	1	IC TL431CLP
U103	1826-1257	1	IC +8V LIN REG
U104	1826-1256	1	IC SWTCHG REGLTR
U105	1826-0994	1	IC LM337LZ
U201-204,304	1826-0785	5	IC OP AMP
U205,206,303	1820-1315	3	IC-MC14051BCP
U207,301	1826-0501	2	ANLG MUXR
U208-210	1990-1074	3	OPTO-ISOLATOR
U302	1826-1915	1	OP AMP
ZZ1	43201-86510	1	PC BD-MON ECG
ZZ2	43201-84701	1	LABEL-BAR CODE
	8151-0013		WIRE 22AWG 1X22

REF DESIG	GRID LOC	PART NUMBER
C101	D2	0160-4832
C102	D1	0160-6623
C103	H3	0180-3552
C104	G3	0160-6623
C105	H3	0180-3422
C106	H3	0160-4574
C107	C3	0180-3553
C108	G3	0180-3552
C109	D3	0160-4846
C110	D3	0180-3553
C111	D3	0180-3552
C112	B4	0180-3422
C113	B4	0180-4127
C201	G5	0160-4801
C202	G5	0160-4801
C203	G5	0160-4801
C204	G5	0160-4801
C205	G5	0160-4801
C206	F5	0160-4574
C207	E6	0160-5422
C208	E6	0180-3551
C209	E6	0180-3551
C301	D7	0160-5422
C302	C7	0160-7035
C303	C5	0160-4574
C304	A5	0160-4574
C305	D4	0180-3551
C306	D4	0180-3551
C307	D4	0180-3551
CR101	A3	1902-3094
CR102	D1	1902-0969
CR103	C2	1901-0520
CR104	C2	1901-0520
CR105	G3	1901-0520
CR106	H3	1901-0937
CR107	D3	1901-0520
CR108	D3	1901-0520
CR109	E3	1901-0520
CR110	B3	0837-0193
CR201	G5	1901-0044
CR202	G4	1901-0044
CR203	H5	1901-0044
CR204	H4	1901-0044
CR205	G5	1901-0044
CR206	H5	1901-0044
CR207	G5	1901-0044
CR208	H5	1901-0044
CR209	G5	1901-0044
CR210	H5	1901-0044
CR211	G5	1901-0044
CR212	H5	1901-0044
CR213	G5	1901-0044
CR214	H5	1901-0044
CR215	E4	1901-0044
CR216	E4	1901-0044
CR217	F4	1901-0044
CR218	F4	1901-0044
CR301	D6	1901-0044
CR302	D6	1901-0044
CR303	D6	1901-0044
CR304	D6	1901-0044
CR305	D5	1902-0783
CR306	D5	1902-0783
DS201	G6	2140-0024
DS202	G7	2140-0024
DS203	G7	2140-0024
DS204	G7	2140-0024
DS205	G7	2140-0024
E201	H4	1970-0209
E202	H3	0837-0196
E203	H3	0837-0196
F101	B3	2110-0010
FH101	B3	2110-0643
J2	B1	1251-5829
J26	H7	1251-2557
J3	A1	1251-3659
J30	A4	1252-2403
K101	B2	0490-1696
K102	C2	0490-1696
L101	C4	9140-0983
L301	D4	9100-2265
MP101	D3	1205-0634
MP201	G6	8151-0013
P5	H2	43201-61612
Q101	D1	1855-0696
Q102	B3	1853-0036
Q103	D1	1853-0058
Q301	B6	1855-0437
Q302	B6	1855-0696
Q303	D5	1854-0210
Q304	D5	1854-0210
R101	A2	0698-3446
R102	A2	0698-3446
R103	A2	0698-3446
R104	A2	0698-3446
R105	C1	0698-7933
R106	D1	0699-0047
R107	A3	0757-0280
R108	C1	0757-0280
R109	D2	0698-8827
R110	C1	0757-0442
R111	D2	0698-8137
R112	D1	0698-3450
R113	D1	0683-4745
R114	D1	0698-8958
R115	D1	0698-3450
R116	D2	0757-0442
R117	D2	0757-0442
R118	H3	0757-0280
R119	D2	0698-8695
R120	G3	0698-6343
R121	D2	0698-3266
R122	D1	0698-3441
R123	D2	0699-0047
R124	A3	0757-0200
R125	C3	0811-3605
R126	D3	0698-6343
R127	D3	0698-6348
R128	D3	0757-0467
R129	E3	0683-1815
R130	E3	0698-4455
R201	G4	0757-0465
R202	H4	0757-0465
R203	H6	0698-3920
R204	H6	0698-3920
R205	G5	0683-1065
R206	H6	0698-3920
R207	H6	0698-3920
R208	G5	0683-1065
R209	H6	0698-3920
R210	H6	0698-3920
R211	G5	0683-1065
R212	H6	0698-3920
R213	H6	0698-3920
R214	G4	0683-1065
R215	H6	0698-3920
R216	H6	0698-3920
R217	H6	0698-3920
R218	H6	0698-3920
R219	G4	0757-0465
R220	F4	0757-0465
R221	G7	0757-0442
R222	G7	0757-0442
R223	G7	0757-0442
R224	G7	0757-0442
R225	G7	0757-0442
R226	G7	0757-0442
R227	G7	0757-0442
R228	G7	0757-0442
R229	G7	0757-0442
R230	E8	0757-0442
R231	E7	0757-0442
R232	E5	0757-0465
R233	E5	0698-6942
R234	E6	0757-0465
R235	E5	0757-0442
R236	E6	0757-0442
R237	E5	0698-3441
R238	E6	0698-3441
R239	E7	0757-0442
R240	E5	0757-0465
R241	E4	0757-0442
R242	E8	0757-0465
R243	G8	0757-0465
R244	G8	0757-0465
R245	H4	0699-1993
R246	G3	0699-1993
R301	D7	0757-0442
R302	D7	0757-0442
R303	B6	0698-3159
R304	B6	0698-8827
R305	B6	0698-8827
R306	B5	0757-0465
R307	A6	0698-8827
R308	A6	2100-3353
R309	C5	0698-3260
R310	C5	0757-0439
R311	A5	2100-3273
R312	B8	0698-3158
R313	B8	0757-0442
R314	B7	0698-6343
R315	B7	0698-3136
R316	B7	0698-3158
R317	C8	0757-0447
R318	C8	0698-3160
R319	C7	0757-0123
R320	C7	0757-0123
R321	C7	0757-0465
R322	A6	0757-0442
R323	D5	0698-3154
R324	D5	0698-3154
R325	D7	0698-3154
R326	D8	0698-3154
R327	D8	0698-3154
T201	E6	43100-82730
T202	E5	43100-82720
U101	D2	1826-0412
U102	H2	1826-1258
U103	F3	1826-1257
U104	D4	1826-1256
U105	F3	1826-0994
U201	G6	1826-0785
U202	G6	1826-0785
U203	F5	1826-0785
U204	F5	1826-0785
U205	F6	1820-1315
U206	F7	1820-1315
U207	E7	1826-0501
U208	E7	1990-1074
U209	E7	1990-1074
U210	E7	1990-1074
U301	D7	1826-0501
U302	C6	1826-1915
U303	B6	1820-1315
U304	B5	1826-0785
Z21	A8	43201-86510
Z22	H2	43201-84701

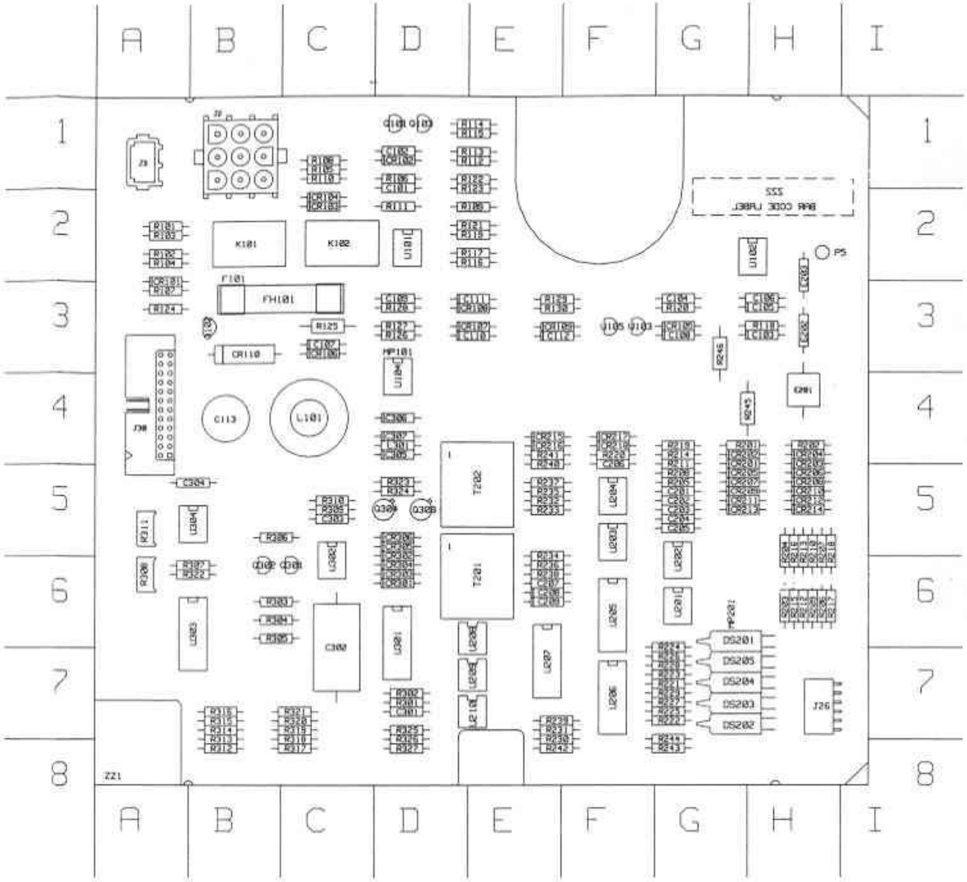


Figure 6-6. A2A3 ECG/Power Supply Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 1 of 4).

A2A3

FUSEHOLDER	2110-0643	FH101
HEAT SINK for U104	1205-0634	MP101
UNLOADED PC BOARD	43201-86510	ZZ1
BARCODE LABEL	43201-84701	ZZ2

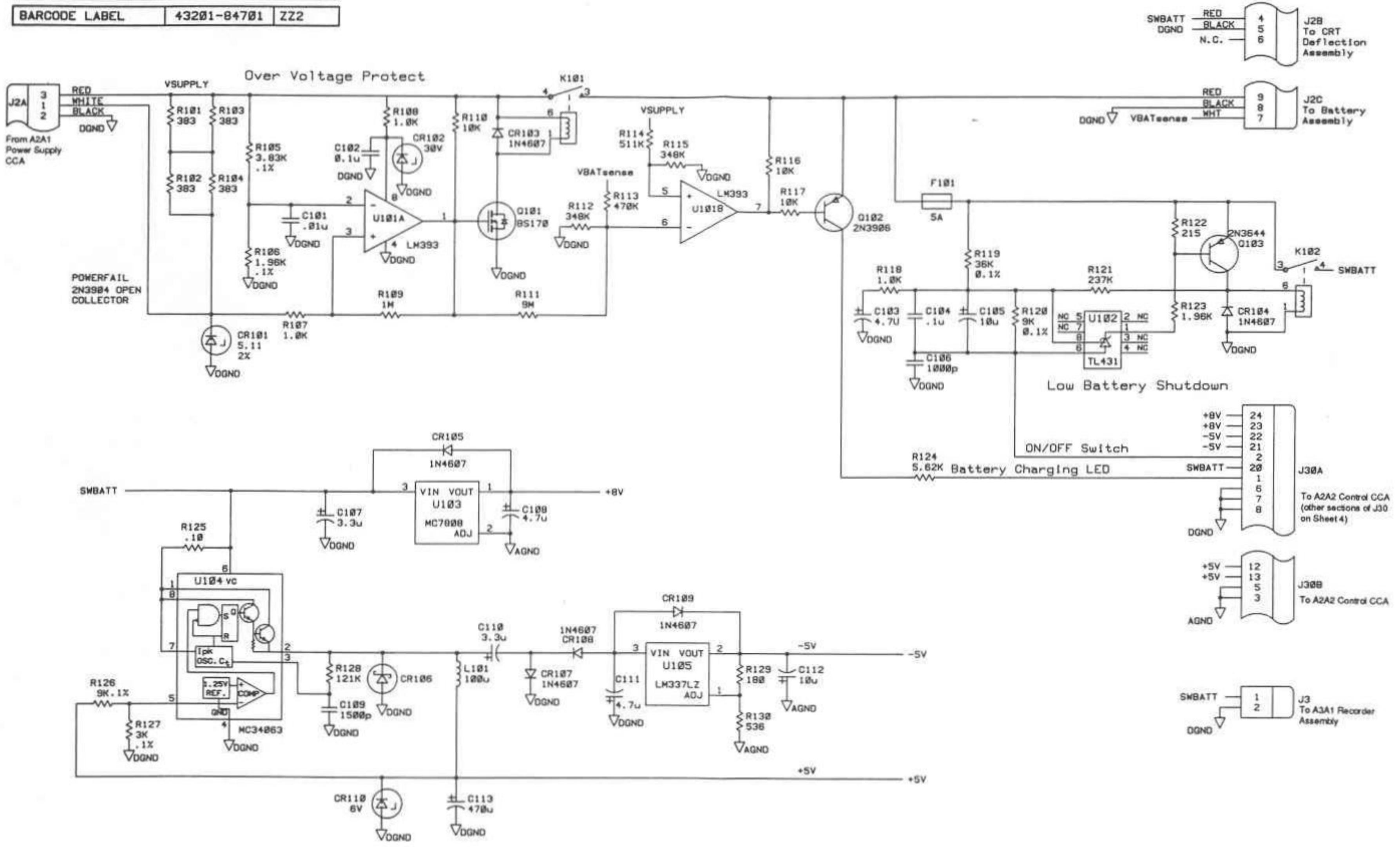

Over Voltage Protect
J2A
RED
WHITE
BLACK
DGND
From A2A1 Power Supply CCA
VSUPPLY
R101 383
R103 383
R102 383
R104 383
R105 3.83K .1%
R106 1.96K .1%
C101 .01u
C102 0.1u
CR102 30V
R108 1.0K
U101A
LM393
POWERFAIL 2N3904 OPEN COLLECTOR
CR101 5.11 2%
R107 1.0K
R109 1M
R110 10K
CR103 1N4607
Q101 BS170
R111 9M
K101
VSUPPLY
R114 511K
R115 348K
VBATsense
R113 470K
R112 348K
U101B
LM393
R116 10K
R117 10K
Q102 2N3906
F101 5A
R119 36K 0.1%
R118 1.0K
C103 4.7U
C104 .1u
C105 10u
C106 1000p
R120 9K 0.1%
R121 237K
U102
TL431
NC
R122 215
2N3644 Q103
R123 1.96K
CR104 1N4607
K102
SWBATT
Low Battery Shutdown
SWBATT
DGND
N.C.
J2B To CRT Deflection Assembly
J2C To Battery Assembly
VBATsense
ON/OFF Switch
R124 5.62K
Battery Charging LED
+8V
+8V
-5V
-5V
J30A
To A2A2 Control CCA (other sections of J30 on Sheet 4)
+5V
+5V
J30B
To A2A2 Control CCA
AGND
J3
To A3A1 Recorder Assembly
CR105 1N4607
VIN VOUT
U103
MC7808 ADJ
C107 3.3u
C108 4.7u
+8V
R125 .10
U104 VC
Ipk OSC. Ct
1.25V REF.
COMP
GND
MC34063
R126 9K.1%
R127 3K .1%
R128 121K
CR106
C109 1500p
L101 100u
C110 3.3u
1N4607 CR108
CR107 1N4607
C111 4.7u
CR109 1N4607
U105
LM337LZ ADJ
R129 180
C112 10u
R130 536
-5V
+5V
CR110 6V
C113 470u
DGND
AGND

Figure 6-6. A2A3 ECG/Power Supply Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 2 of 4).

NEON TIEDOWN .14"	8151-0013	MP201

PINS CONNECTED TO EMBEDDED POWER/GROUND NETS:
U201 4(-6V), 8(+6V)
U202 4(-6V), 8(+6V)
U203 4(-6V), 8(+6V)
U204 4(-6V), 8(+6V)
U205 7(-6V), 8(-6V), 16(+6V)
U206 7(-6V), 8(-6V), 16(+6V)
U207 7(-6V), 8(-6V), 16(+6V)

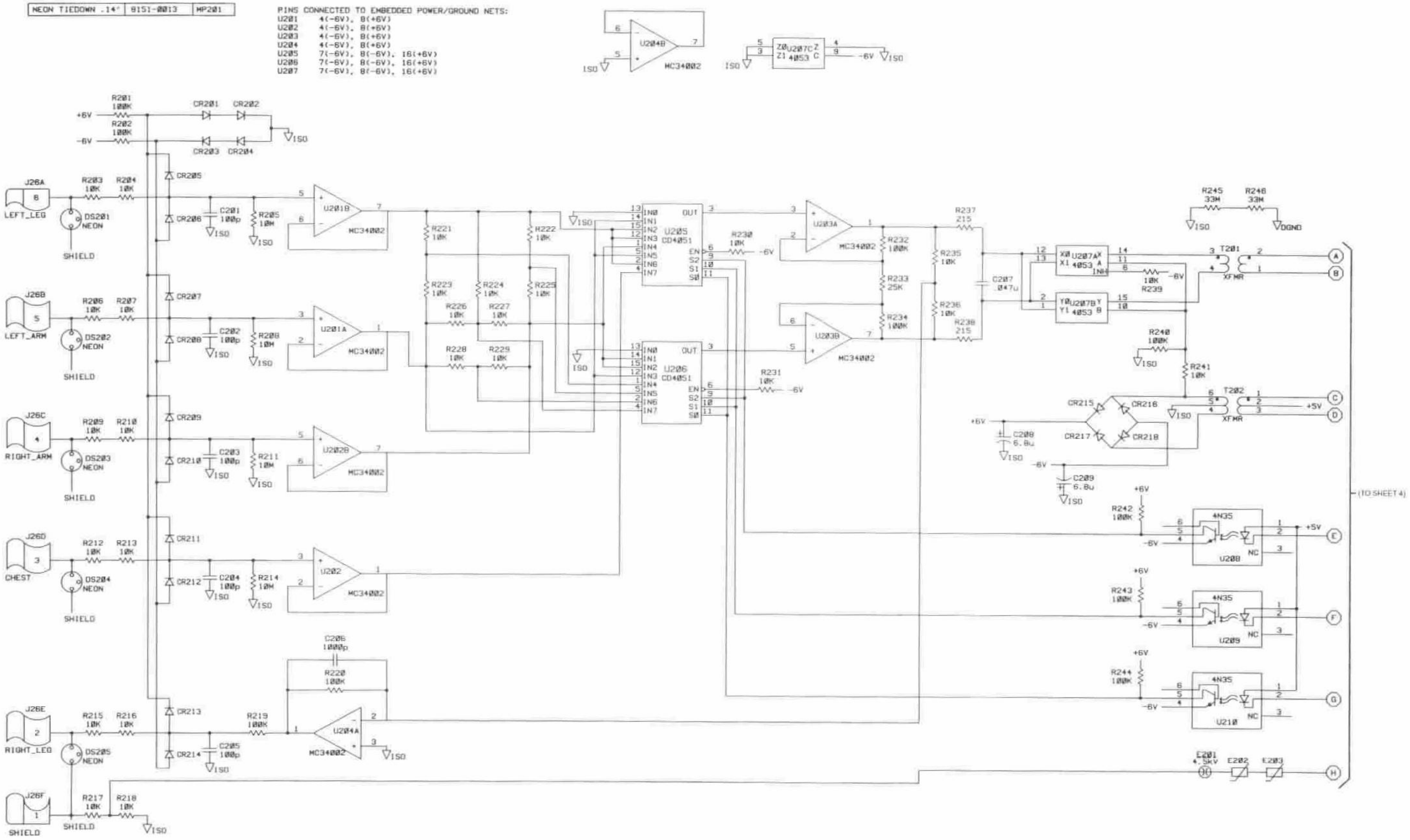
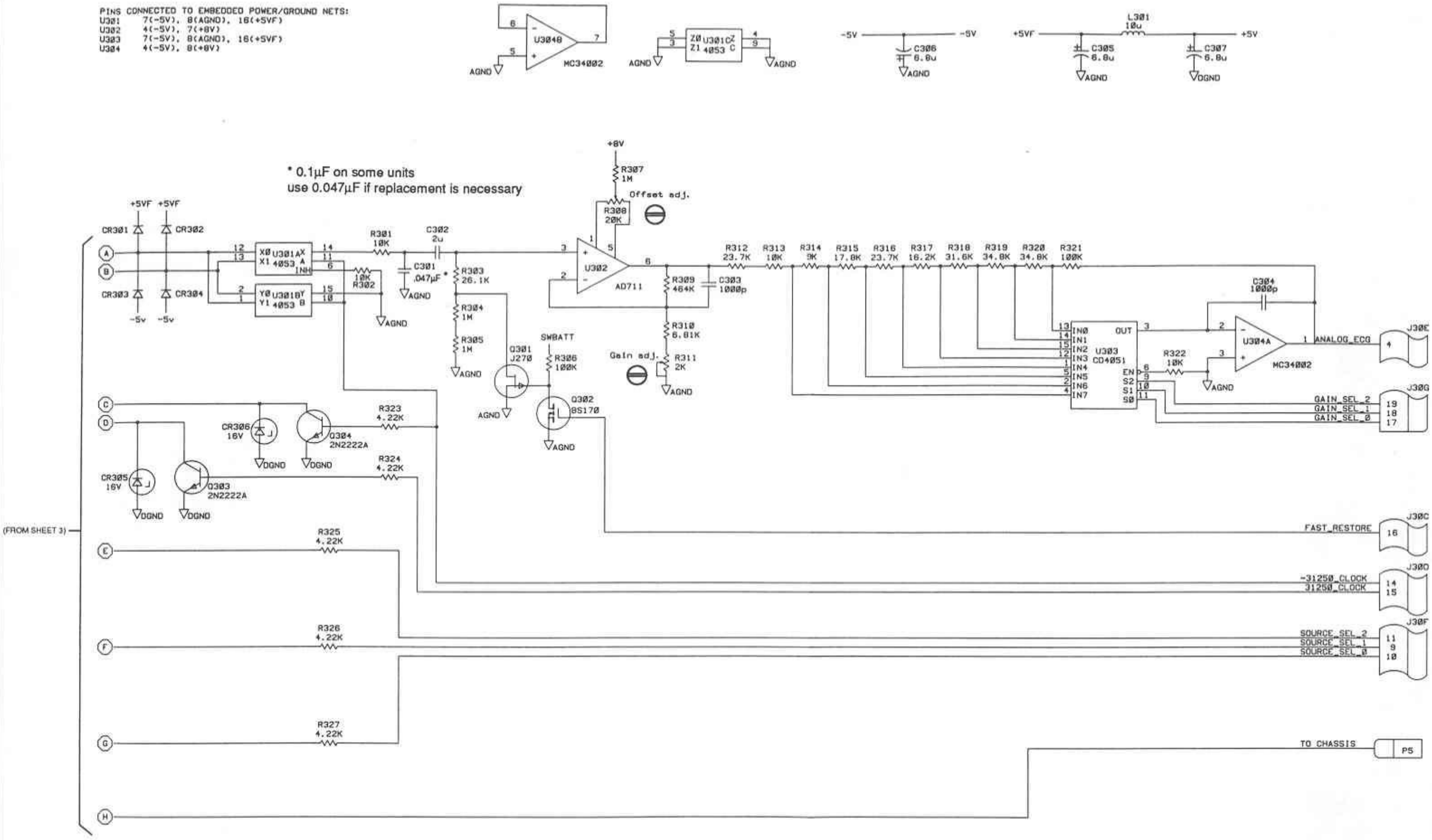

U204B
MC34002
ISO
Z0 U207C Z
Z1 4053 C
-6V
R201 100K
R202 100K
+6V
-6V
CR201
CR202
CR203
CR204
CR205
CR206
CR207
CR208
CR209
CR210
CR211
CR212
CR213
CR214
J26A
LEFT_LEG
DS201 NEON
SHIELD
R203 10K
R204 10K
C201 100p
R205 10M
U201B
MC34002
J26B
LEFT_ARM
DS202 NEON
R206 10K
R207 10K
C202 100p
R208 10M
U201A
J26C
RIGHT_ARM
DS203 NEON
R209 10K
R210 10K
C203 100p
R211 10M
U202B
J26D
CHEST
DS204 NEON
R212 10K
R213 10K
C204 100p
R214 10M
U202
C206 1000p
R220 100K
J26E
RIGHT_LEG
DS205 NEON
R215 10K
R216 10K
C205 100p
R219 100K
U204A
J26F
R217 10K
R218 10K
R221 10K
R222 10K
R223 10K
R224 10K
R225 10K
R226 10K
R227 10K
R228 10K
R229 10K
U205 CD4051
U206 CD4051
IN0 IN1 IN2 IN3 IN4 IN5 IN6 IN7
OUT
EN S2 S1 S0
R230 10K
R231 10K
U203A
U203B
R232 100K
R233 25K
R234 100K
R235 10K
R236 10K
R237 215
R238 215
C207 .047u
X0 U207A X
X1 4053 A
INH
Y0 U207B Y
Y1 4053 B
R239 10K
R240 100K
R241 10K
R245 33M
R246 33M
DGND
T201
T202
XFMR
+5V
CR215
CR216
CR217
CR218
C208 6.8u
C209 6.8u
R242 100K
R243 100K
R244 100K
4N35
U208
U209
U210
NC
E201 4.5kV
E202
E203
A
B
C
D
E
F
G
H
(TO SHEET 4)

Figure 6-6. A2A3 ECG/Power Supply Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 3 of 4).



PINS CONNECTED TO EMBEDDED POWER/GROUND NETS:

U301	7(-5V), 8(AGND), 16(+5VF)
U302	4(-5V), 7(+8V)
U303	7(-5V), 8(AGND), 16(+5VF)
U304	4(-5V), 8(+8V)

* 0.1µF on some units
use 0.047µF if replacement is necessary

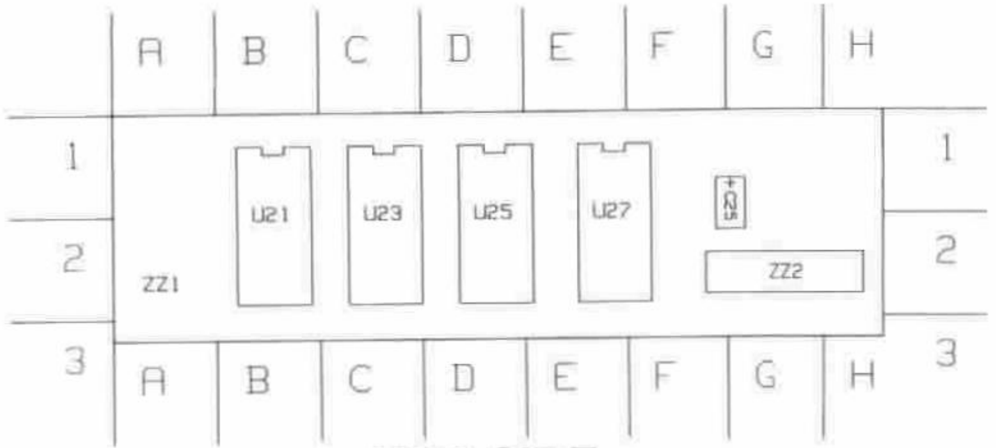
U304B
MC34002
AGND
Z0 U301C Z
Z1 4053 C
-5V
C306 6.8u
+5VF
L301 10u
C305 6.8u
C307 6.8u
+5V
DGND
+8V
R307 1M
Offset adj.
R308 20K
+5VF
CR301
CR302
CR303
CR304
-5v
X0 U301A X
X1 4053 A INH
Y0 U301B Y
Y1 4053 B
R301 10K
R302 10K
C302 2u
C301 .047µF *
R303 26.1K
R304 1M
R305 1M
U302
AD711
R309 464K
C303 1000p
R310 6.81K
Gain adj.
R311 2K
Q301 J270
SWBATT
R306 100K
Q302 BS170
R312 23.7K
R313 10K
R314 9K
R315 17.8K
R316 23.7K
R317 16.2K
R318 31.6K
R319 34.8K
R320 34.8K
R321 100K
C304 1000p
U303 CD4051
IN0 IN1 IN2 IN3 IN4 IN5 IN6 IN7
OUT EN S2 S1 S0
R322 10K
U304A
MC34002
ANALOG_ECG
J30E
GAIN_SEL_2
GAIN_SEL_1
GAIN_SEL_0
J30G
CR306 16V
Q304 2N2222A
R323 4.22K
CR305 16V
Q303 2N2222A
R324 4.22K
(FROM SHEET 3)
R325 4.22K
FAST_RESTORE
J30C
-31250_CLOCK
31250_CLOCK
J30D
R326 4.22K
SOURCE_SEL_2
SOURCE_SEL_1
SOURCE_SEL_0
J30F
R327 4.22K
TO CHASSIS
P5
A B C D E F G H

Figure 6-6. A2A3 ECG/Power Supply Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 4 of 4).

43201-66550 A2A4 ECG Memory Circuit Card Assembly
See Figure 6-7 for Parts Breakdown

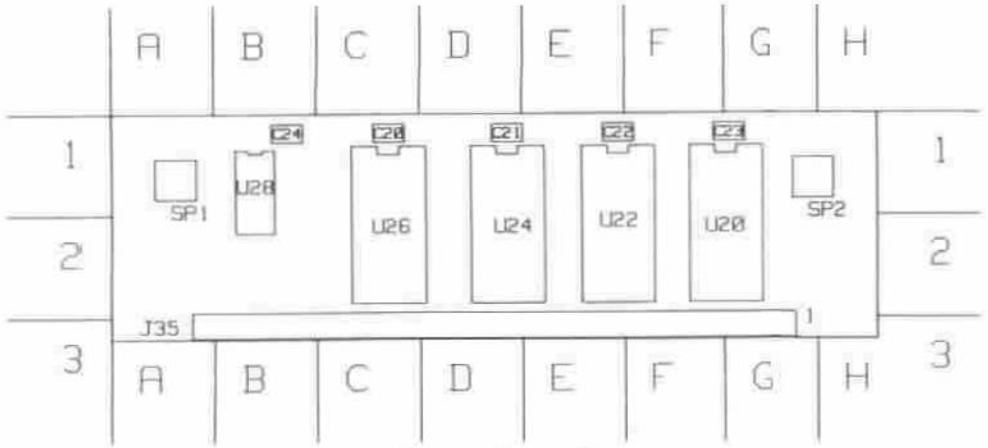
Reference Designator	Part Number	Qty	Description
C20-24	0160-6497	5	CAP-SMD .1UF 10%
C25	0180-3982	1	C-F 15UF 10V TA
J35	1252-3017	1	CONNECTOR
SP1,2	0380-2023	2	SPACER
U20-27	1818-4107	8	SRAM-256K
U28	1820-4121	1	DECODER,3-8 LINE
ZZ1	43201-86550	1	PC BD-MON MEM
ZZ2	43201-84705	1	LABEL-BAR CODE

REF DESIG	GRID LOC	PART NUMBER
C25	F1	0180-3982
U21	B1	1818-4107
U23	C1	1818-4107
U25	D1	1818-4107
U27	E1	1818-4107
ZZ1	A2	43201-86550
ZZ2	G2	43201-84705


A
B
C
D
E
F
G
H
1
2
3
U21
U23
U25
U27
C25
ZZ1
ZZ2

TOP SIDE

REF DESIG	GRID LOC	PART NUMBER
C20	C1	0160-6497
C21	D1	0160-6497
C22	E1	0160-6497
C23	F1	0160-6497
C24	B1	0160-6497
J35	A3	1252-3017
SP1	A2	0380-2023
SP2	G2	0380-2023
U20	F2	1818-4107
U22	E2	1818-4107
U24	D2	1818-4107
U26	C2	1818-4107
U28	B1	1820-4121


A
B
C
D
E
F
G
H
1
2
3
C24
C20
C21
C22
C23
SP1
U28
U26
U24
U22
U20
SP2
J35
1

BOTTOM SIDE

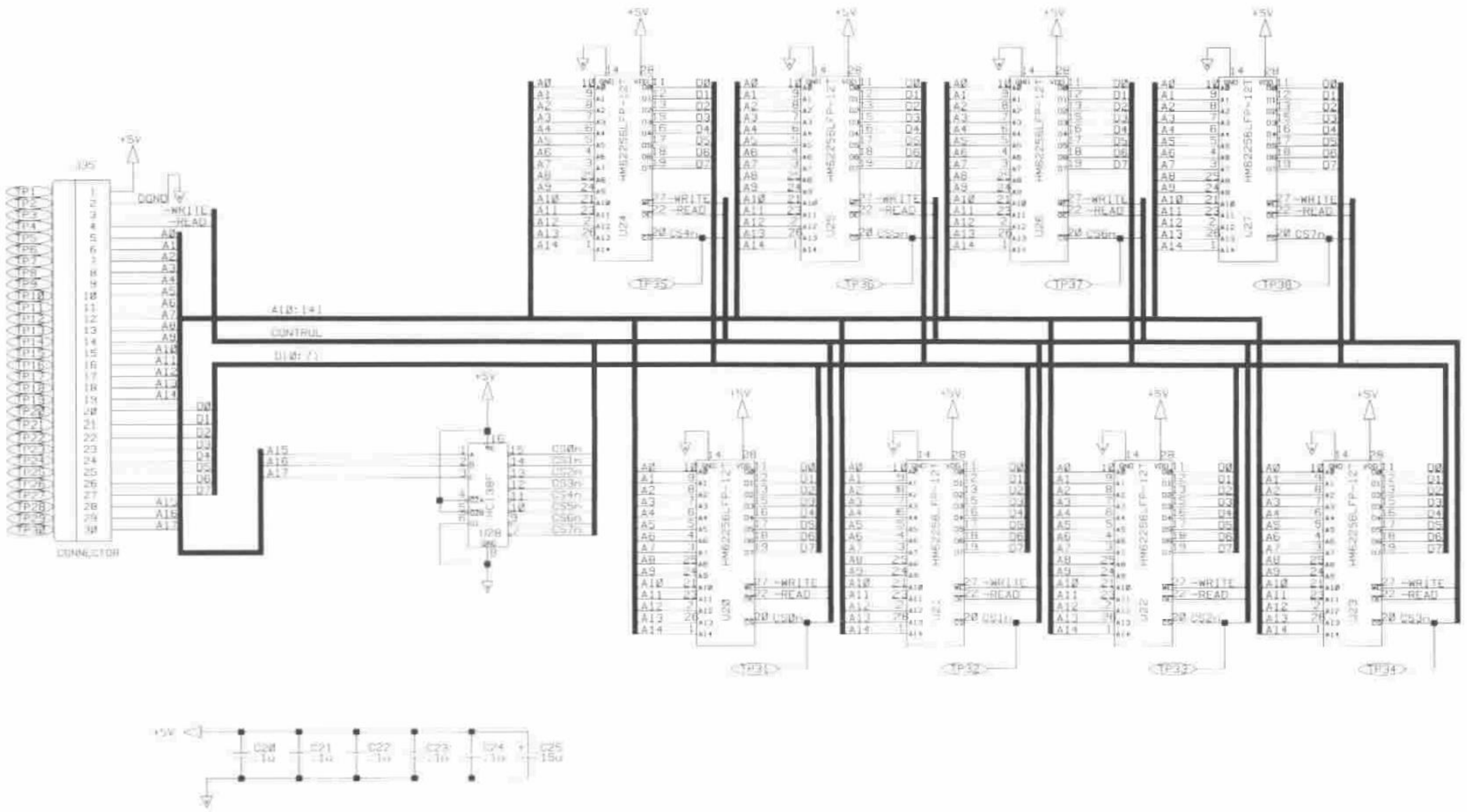

+5V
J35
CONNECTOR
DGND
-WRITE
-READ
A0
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
D0
D1
D2
D3
D4
D5
D6
D7
A15
A16
A17
A0:14
CONTROL
D0:7
U28
U20
U21
U22
U23
U24
U25
U26
U27
HM62256LFP-12
TP31
TP32
TP33
TP34
TP35
TP36
TP37
TP38
C20
C21
C22
C23
C24
C25

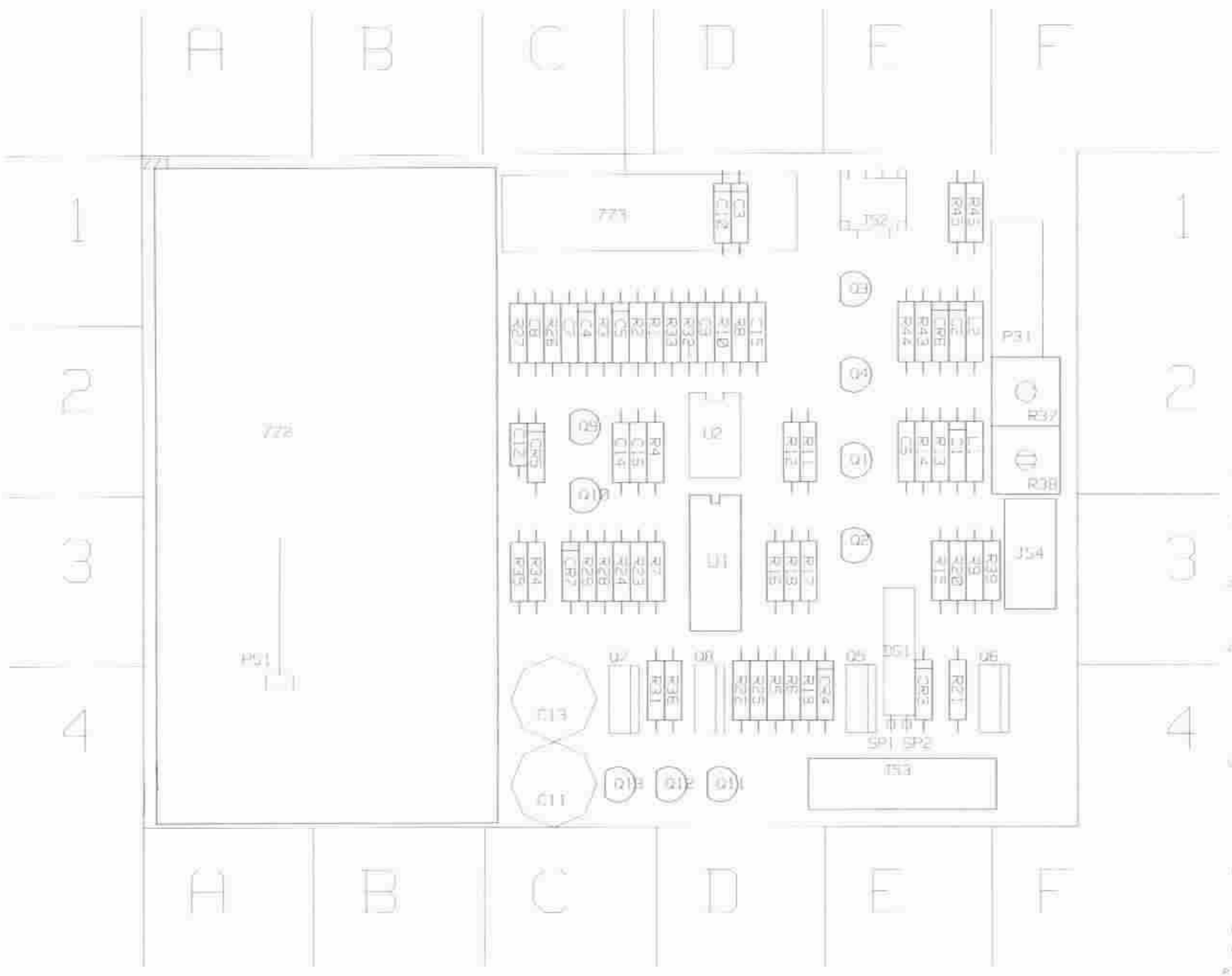
Figure 6-7. A2A4 ECG Memory Circuit Card Assembly Component Locator and Schematic Diagram.

A2A4

43201-66570 A2A5 CRT Deflection Circuit Card Assembly
See Figure 6-8 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
C1,2	0180-3551	2	CAP-FIXED 6.8UF
C3,6,14-16	0160-6623	5	CAP.1UF 20% 50V
C4,5	0180-3622	2	CAP-FIXED-ELEC
C7,8	0160-3335	2	CAP 470PF 10%
C9	0160-4801	1	CAP 100PF 5%
C10	0180-3552	1	CAP-FIXED 4.7UF
C11,13	0180-2746	2	C-F 330UF 20V AL
C12	0160-4230	1	CAP .01UF +80
CR3-5	1901-0044	3	DIO-SWITCHING
CR6	1902-0954	1	DIO-ZNR 6.8V 5%
CR7	1901-0937	1	DIODE, SCHOTTKY
DS1	2140-0024	1	LAMP-A3C
J52	1251-3659	1	CONN UTIL
J53	1251-4350	1	CONN-7-PIN M
J54	1251-4349	1	CONN-4-PIN M
L1,2	9100-2265	2	INDCTR 10UH 10%
P31	43100-61609	1	CBL ASSY
Q1,3	1854-0210	2	XSTR-NPN 2N2222
Q2,4,13	1853-0281	3	XSTOR 2N2907A
Q5,7	1854-0670	2	XSTR NPN SI DARL
Q6,8	1853-0377	2	XSTR PNP SI DARL
Q9,10	1854-0365	2	XSTR NPN SI
Q11,12	1855-0696	2	TRANSISTOR
R1	0698-3458	1	RES-348K 1% .125
R2	0698-8827	1	RESISTOR 1M
R3	0757-0458	1	RES-51.1K 1% .12
R4-7	0699-0272	4	RES-75K .1% .125
R8,11-13,23,24	0757-0462	6	RES-75K 1% .125W
R9,21,39	0683-1005	3	RES-10 OHM 5%
R10,14,31	0757-0460	3	RES-61.9K 1% .12
R15,35,45,46	0757-0280	4	RES-1K 1% .125W
R16-19	0699-0847	4	RES 1.96 .1%
R20,22,26,34	0757-0442	4	RES-10K 1% .125
R25	0757-0418	1	RES 619 1% .125W
R27,43,44	0698-3438	3	RES 147 1% .125W
R28	0683-2255	1	RES-2.2M 5% .25W
R29	0757-0123	1	RES-34.8K 1% .12
R32,33,36	0757-0180	3	RES 31.6 1%
R37,38	2100-0558	2	RES-VAR 20K 10%
SP1-2	4330-0145	2	INSULATOR BEAD
U1	1826-1422	1	IC 34084
U2	1826-1286	1	OP AMP DUAL CMOS
ZZ1	43100-80131	1	PC BOARD
ZZ2	0950-1690	1	POWER SUPPLY
ZZ3	43201-84706	1	LABEL-BAR CODE

REF DESIG	GRID LOC	PART NUMBER
C1	E2	0180-3551
C2	E1	0180-3551
C3	D1	0160-6623
C4	C1	0180-3622
C5	C1	0180-3622
C6	E2	0160-6623
C7	C1	0160-3335
C8	C1	0160-3335
C9	D1	0160-4801
C10	D1	0180-3552
C11	C4	0180-2746
C12	C2	0160-4230
C13	C4	0180-2746
C14	C2	0160-6623
C15	D1	0160-6623
C16	C2	0160-6623
CR3	E4	1901-0044
CR4	D4	1901-0044
CR5	C2	1901-0044
CR6	E1	1902-0954
CR7	C3	1901-0937
DS1	E3	2140-0024
J53	E4	1251-4350
J54	F3	1251-4349
J52	E1	1251-3659
L1	E2	9100-2265
L2	E1	9100-2265
P31	F2	43100-61609
Q1	E2	1854-0210
Q2	E3	1853-0281
Q3	E1	1854-0210
Q4	E2	1853-0281
Q5	E3	1854-0670
Q6	E3	1853-0377
Q7	C3	1854-0670
Q8	D3	1853-0377
Q9	C2	1854-0365
Q10	C3	1854-0365
Q11	D4	1855-0696
Q12	D4	1855-0696
Q13	C4	1853-0281
R1	C1	0698-3458
R2	C1	0698-8827
R3	C1	0757-0458
R4	C2	0699-0272
R5	D4	0699-0272
R6	D4	0699-0272
R7	C3	0699-0272
R8	D1	0757-0462
R9	E3	0683-1005
R10	D1	0757-0460
R11	D2	0757-0462
R12	D2	0757-0462
R13	E2	0757-0462
R14	E2	0757-0460
R15	E3	0757-0280
R16	D3	0699-0847
R17	D3	0699-0847
R18	D3	0699-0847
R19	D4	0699-0847
R20	E3	0757-0442
R21	E4	0683-1005
R22	D4	0757-0442
R23	C3	0757-0462
R24	C3	0757-0462
R25	D4	0757-0410
R26	C1	0757-0442
R27	C1	0698-3438
R28	C3	0683-2255
R29	C3	0757-0123
R31	C4	0757-0460
R32	D1	0757-0180
R33	D1	0757-0180
R34	C3	0757-0442
R35	C3	0757-0280
R36	D4	0757-0180
R37	F2	2100-0558
R38	F2	2100-0558
R39	E3	0683-1005
R43	E1	0698-3438
R44	E1	0698-3438
R45	E1	0757-0280
R46	E1	0757-0280
U1	D3	1826-1422
U2	D2	1826-1286
ZZ1	A1	43100-80131
ZZ2	A2	0950-1690
ZZ3	C1	43201-84706
SP1	E4	4330-0145
SP2	E4	4330-0145


A
B
C
D
E
F
1
2
3
4
ZZ1
ZZ2
ZZ3
J52
P31
R37
R38
J54
U1
U2
C13
C11
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
DS1
P51
J53
SP1 SP2

PCB	43100-80131	ZZ1
HV MODULE	0950-1690	ZZ2
BAR CODE LABEL	43201-84706	ZZ3
INSULATOR BEAD	4330-0145	SP1-2

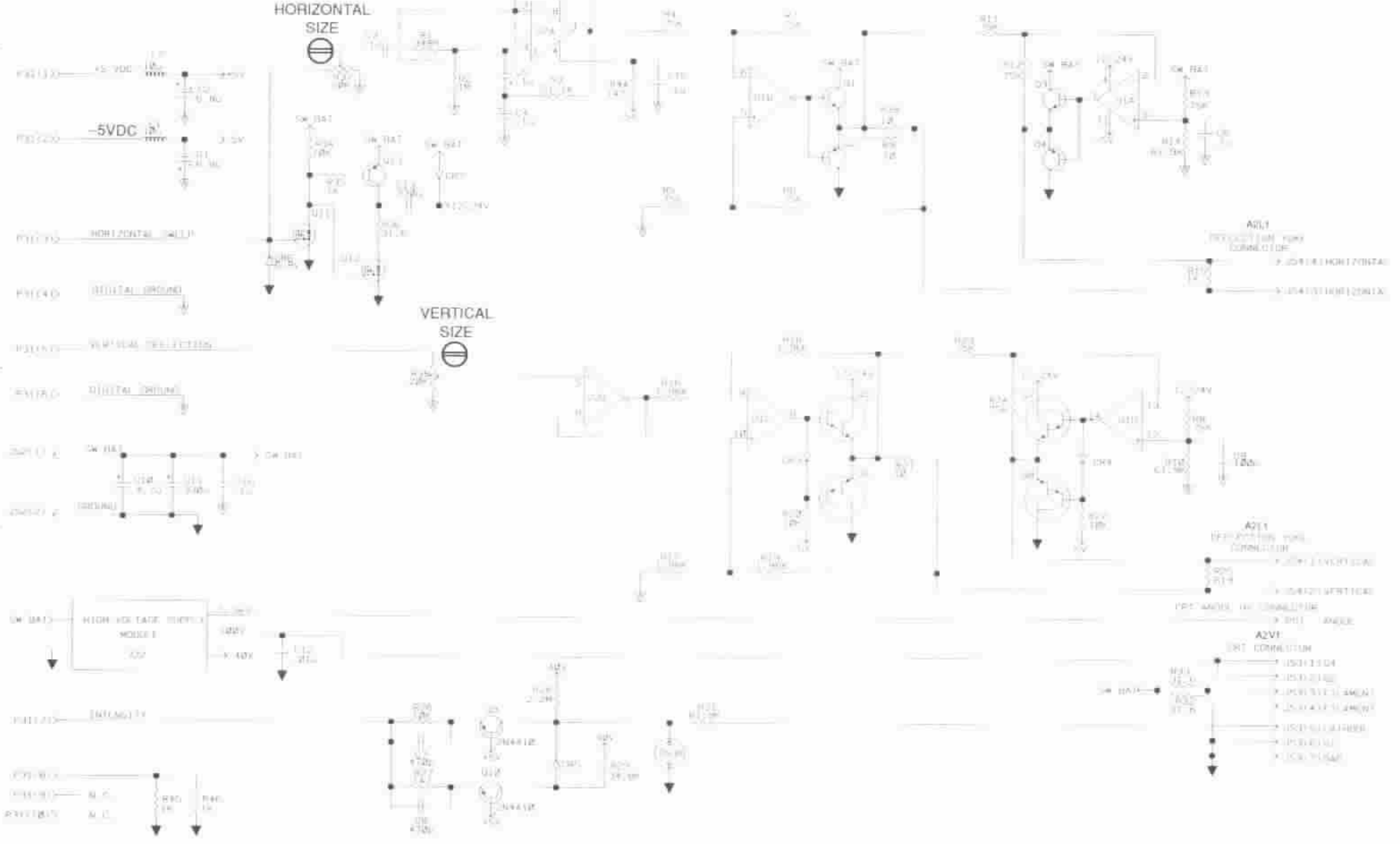
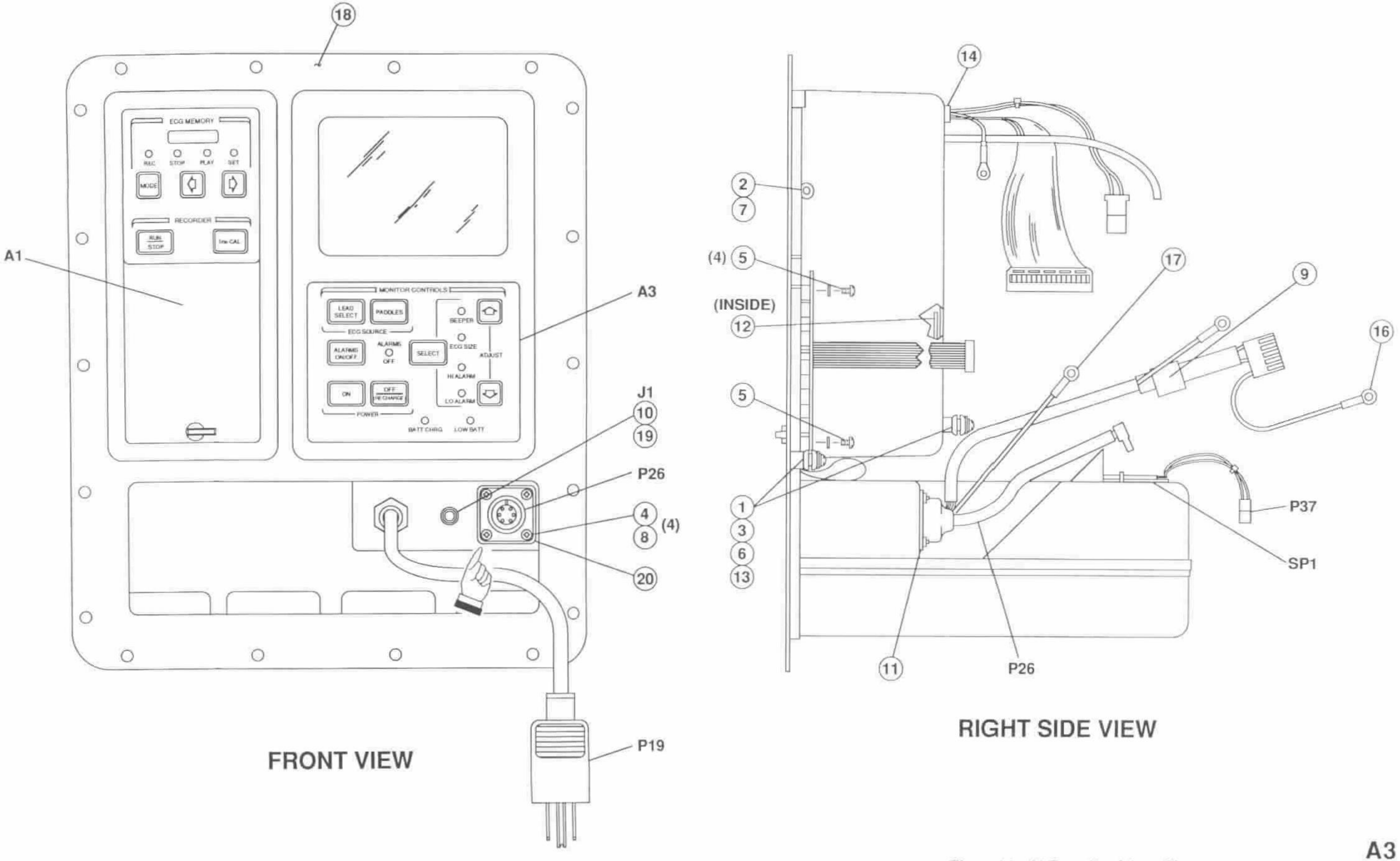

HORIZONTAL SIZE
-5VDC
HORIZONTAL SWEEP
DIGITAL GROUND
VERTICAL SIZE
VERTICAL DEFLECTION
DIGITAL GROUND
HIGH VOLTAGE SUPPLY MODULE
INTENSITY
A2L1
A2V1

Figure 6-8. A2A5 CRT Deflection Circuit Card Assembly Component Locator and Schematic Diagram.

43201-67202 A3 Front Panel Assembly
See Figure 6-9 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43201-67102	1	RECORDER-MON
A2	43201-66530	1	PC ASSY-MON DSPL
A3	43201-67200	1	MEMBRANE SW CNTL
J1	1510-0038	1	BINDING POST-SGL
P19	43201-61604	1	CBL AY-AC PWR
P26	43201-61608	1	CBL AY-ECG INPUT
P37	43201-61602	1	CBL AY-SPEAKER
SP1	9160-0292	1	SPEAKER
6-9-1	0400-0333	2	SHOCK MOUNT
6-9-2	0510-0045	1	RTNR-R E-R EXT
6-9-3	2190-0758	2	WASHER - 8-.5
6-9-4	2200-0769	4	PHMS 4-40
6-9-5	2360-0113	6	PHMS-6-32X.25 P
6-9-6	2510-0051	2	PHMS-8-32X.625 P
6-9-7	3050-0138	1	WSHR - FLAT 10
6-9-8	3050-0222	4	WSHR - FLAT NO. 4
6-9-9	9100-4799	1	BEAD-SHIELD
6-9-10	43131-27301	1	ACORN NUT 1/4-32
6-9-11	43201-07315	1	ECG NUT PLATE
6-9-12	43201-07400	1	EJECT SPRING
6-9-13	43201-27301	2	SPACER 8 THREAD
6-9-14	43201-47311	1	CABLE SEAL
6-9-15	43201-47314	2	DETENT BUTTON
6-9-16	43201-61605	1	CBL ASY-PS GND
6-9-17	43201-61606	1	CBL ASY-GRD TERM
6-9-18	43201-67203	1	PLAS FR PNL ASSY
6-9-19	2950-0071	1	NUT 1/4-32
6-9-20	43201-07903	1	GASKET
	0890-0547	1	HS TBG .75 X 1.5
	43201-84502	1	LBL- ECG AND AC


18
A1
ECG MEMORY
REC
STOP
PLAY
SET
MODE
RECORDER
RUN STOP
1mv CAL
MONITOR CONTROLS
LEAD SELECT
PADDLES
ECG SOURCE
BEEPER
ECG SIZE
ADJUST
ALARMS ON/OFF
ALARMS OFF
SELECT
HI ALARM
LO ALARM
ON
OFF RECHARGE
POWER
BATT CHRG
LOW BATT
A3
J1
10
19
P26
4
8
(4)
20
P19
14
2
7
(4) 5
(INSIDE)
12
5
1
3
6
13
17
9
16
P37
SP1
11
P26

FRONT VIEW

RIGHT SIDE VIEW

Figure 6-9. A3 Front Panel Assembly Component Locator.

43201-67102 A3A1 Recorder Assembly
See Figure 6-10 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
A1	43201-66520	1	PC AY-RCDR DISPL
A2	43201-66560	1	PC ASSY-RECORDER
A3	43201-67201	1	MEMBRANE SW REC
P43	1810-0754	1	PRINTHEAD
P44	43100-61606	1	RCDR CBL
6-10-1	0510-0045	2	RTNR-R E-R EXT
6-10-2	0510-0810	2	RTNR-R E-R EXT
6-10-3	0515-1548	3	PHMS-M2.5 X 0.45
6-10-4	0520-0129	2	SCR MACH 2-56
6-10-5	1430-0617	2	GEAR - SPROCKET
6-10-6	1460-1751	1	SPRING-CPRSN
6-10-7	1500-0672	1	CHAIN-GEAR DRIVE
6-10-8	2200-0103	2	PHMS-4-40X.25 P
6-10-9	2200-0107	9	PHMS 4-40X.375
6-10-10	2360-0127	2	PHMS 6-32 X .875
6-10-11	2580-0017	1	NUT-W/LKWSR 8-32
6-10-12	3030-0964	1	SET SCREW 8-32
6-10-13	3050-0161	1	WSHR WAVE
6-10-14	3140-0789	1	MOTOR-D.C.
6-10-15	43100-02803	1	SPRING-COMPRSN
6-10-16	43100-07316	1	STRIPPER-PAPER
6-10-17	43100-27305	1	PIVOT PIN
6-10-18	43100-27306	1	RCDR PCB STDF
6-10-19	43100-27314	1	PIN-PIVOT
6-10-20	43100-27315	1	RETAINER SHAFT
6-10-21	43100-40040	1	SHTR-MOT CONT
6-10-22	43100-40048	1	RETAINER ARM
6-10-23	43100-67001	1	SPINDLE ASSY
6-10-24	43100-67002	1	PAPER HSING ASSY
6-10-25	43100-67003	1	MOTOR MNT ASSY
6-10-26	43100-82901	2	SPRING-PRINTHEAD
6-10-27	43201-27300	1	PIVOT PIN
6-10-28	43201-47301	1	RECORDER COVER
6-10-29	43201-47305	1	REC LATCH KNOB
6-10-30	43201-47306	1	REC LATCH
6-10-31	43201-47307	1	PRINTHEAD RELEAS
6-10-32	43201-47312	2	PLAS RIB CBL CLM
6-10-33	43201-61601	1	CBL AY-RCDR GND
6-10-34	0510-0166	1	RTNR-R E-R EXT
6-10-35	43201-07906	1	SHIELD, MOTOR
6-10-36	43201-07907	1	SHIELD, PC BOARD
	43100-84576	1	LABEL-SPINDLE

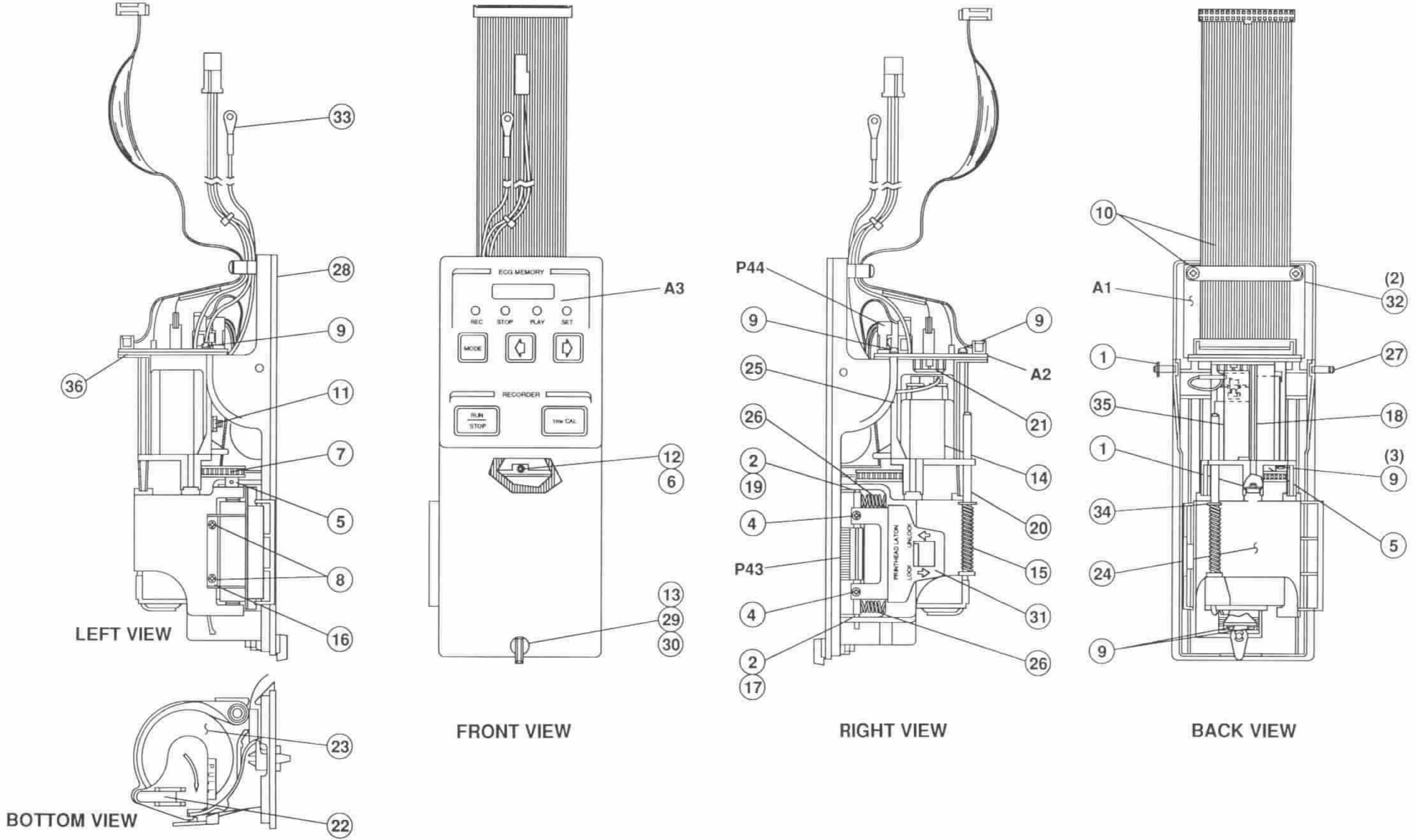
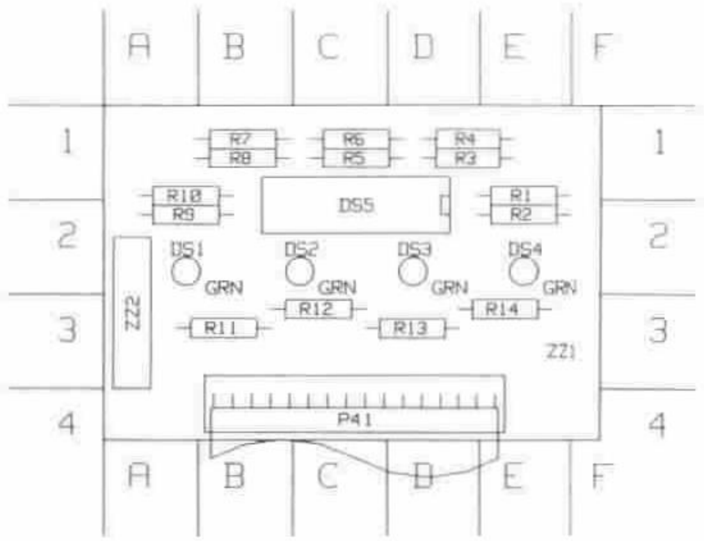

33
28
9
36
11
7
5
8
16
LEFT VIEW
23
22
BOTTOM VIEW
ECG MEMORY
REC
STOP
PLAY
SET
MODE
RECORDER
RUN
STOP
1mv CAL
A3
12
6
13
29
30
FRONT VIEW
P44
9
25
26
2
19
4
PRINTHEAD LATCH
UNLOCK
LOCK
P43
4
2
17
9
A2
21
14
20
15
31
26
RIGHT VIEW
10
A1
1
35
1
34
24
9
(2)
32
27
18
(3)
9
5
BACK VIEW

Figure 6-10. A3A1 Recorder Assembly Component Locator.

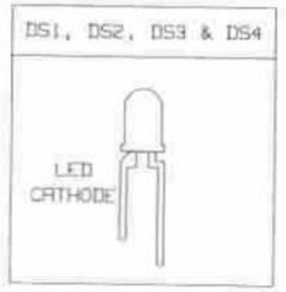
43201-66520 A3A1A1 Recorder Display Circuit Card Assembly
See Figure 6-11 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
DS1-4	1990-1293	4	LED-LMP
DS5	1990-1141	1	LED-LMP ARY
P41	8120-5274	1	CBL-FLAT RIBBON
R1-10	0698-3441	10	RES 215 1% .125W
R11-14	0757-0280	4	RES-1K 1% .125W
ZZ1	43201-86520	1	PC BD-RCDR DSPL
ZZ2	43201-84702	1	LABEL-BAR CODE

REF DESIG	GRID LOC	PART NUMBER
DS1	A2	1990-1293
DS2	B2	1990-1293
DS3	D2	1990-1293
DS4	E2	1990-1293
DS5	C2	1990-1141
P41	C4	8120-5274
R1	E2	0698-3441
R10	A2	0698-3441
R11	B3	0757-0280
R12	C3	0757-0280
R13	D3	0757-0280
R14	E3	0757-0280
R2	E2	0698-3441
R3	D1	0698-3441
R4	D1	0698-3441
R5	C1	0698-3441
R6	C1	0698-3441
R7	B1	0698-3441
R8	B1	0698-3441
R9	A2	0698-3441
ZZ1	E3	43201-86520
ZZ2	A3	43201-84702


A
B
C
D
E
F
1
2
3
4
R7
R8
R6
R5
R4
R3
R10
R9
DS5
R1
R2
ZZ2
DS1
DS2
DS3
DS4
GRN
GRN
GRN
GRN
R11
R12
R13
R14
ZZ1
P41

PCB	43201-86520	ZZ1
BAR CODE LABEL	43201-84702	ZZ2


DS1, DS2, DS3 & DS4
LED
CATHODE

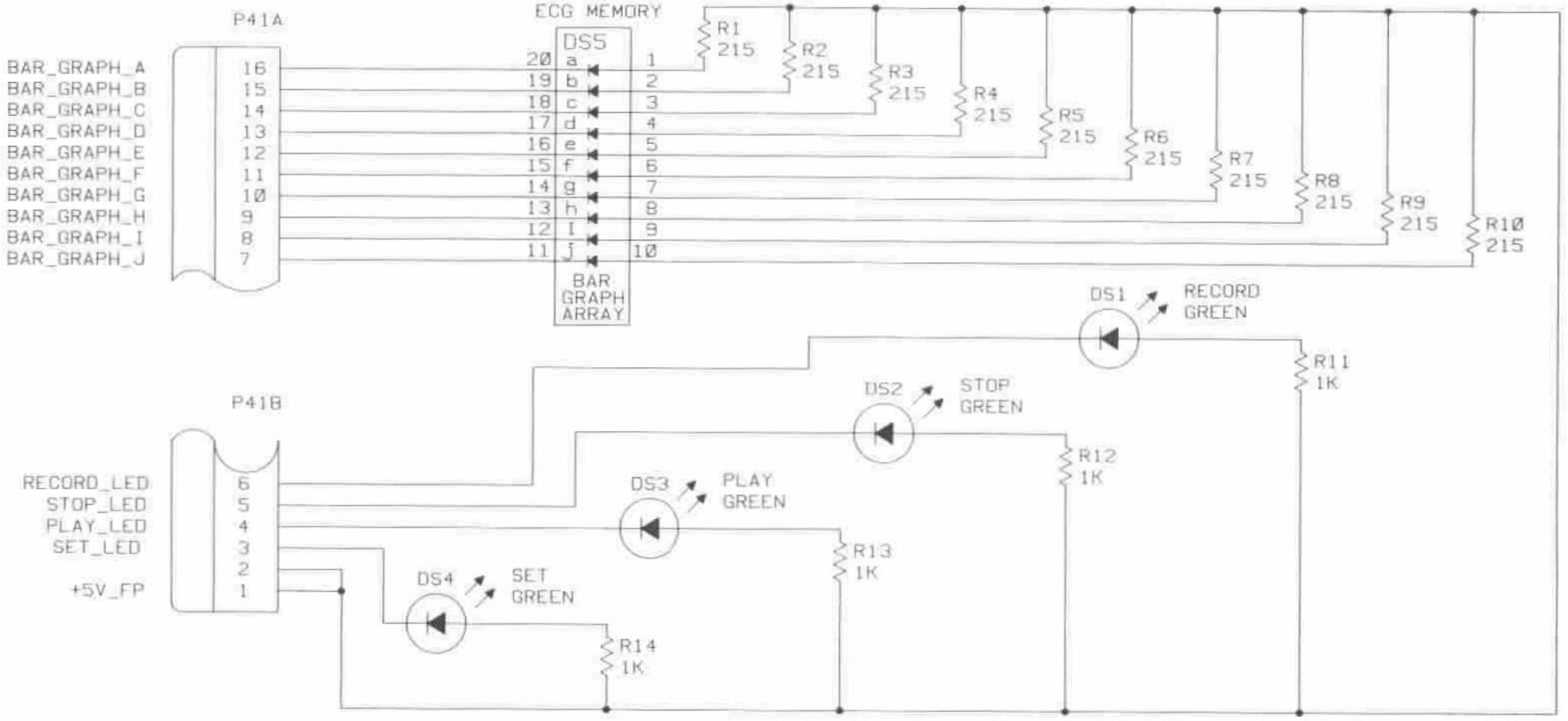

P41A
ECG MEMORY
DS5
BAR_GRAPH_A
BAR_GRAPH_B
BAR_GRAPH_C
BAR_GRAPH_D
BAR_GRAPH_E
BAR_GRAPH_F
BAR_GRAPH_G
BAR_GRAPH_H
BAR_GRAPH_I
BAR_GRAPH_J
16
15
14
13
12
11
10
9
8
7
20 a 1
19 b 2
18 c 3
17 d 4
16 e 5
15 f 6
14 g 7
13 h 8
12 i 9
11 j 10
BAR
GRAPH
ARRAY
R1 215
R2 215
R3 215
R4 215
R5 215
R6 215
R7 215
R8 215
R9 215
R10 215
P41B
RECORD_LED
STOP_LED
PLAY_LED
SET_LED
+5V_FP
6
5
4
3
2
1
DS1
RECORD GREEN
DS2
STOP GREEN
DS3
PLAY GREEN
DS4
SET GREEN
R11 1K
R12 1K
R13 1K
R14 1K

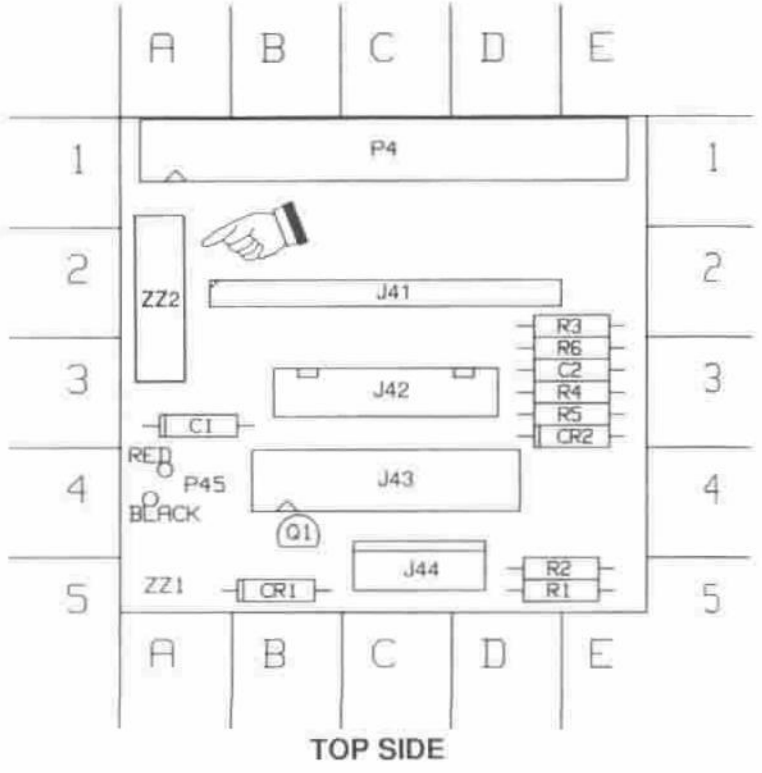
Figure 6-11. A3A1A1 Recorder Display Circuit Card Assembly Component Locator and Schematic Diagram.

A3A1A1

43201-66560 A3A1A2 Recorder Interface Circuit Card Assembly
See Figure 6-12 for Parts Breakdown

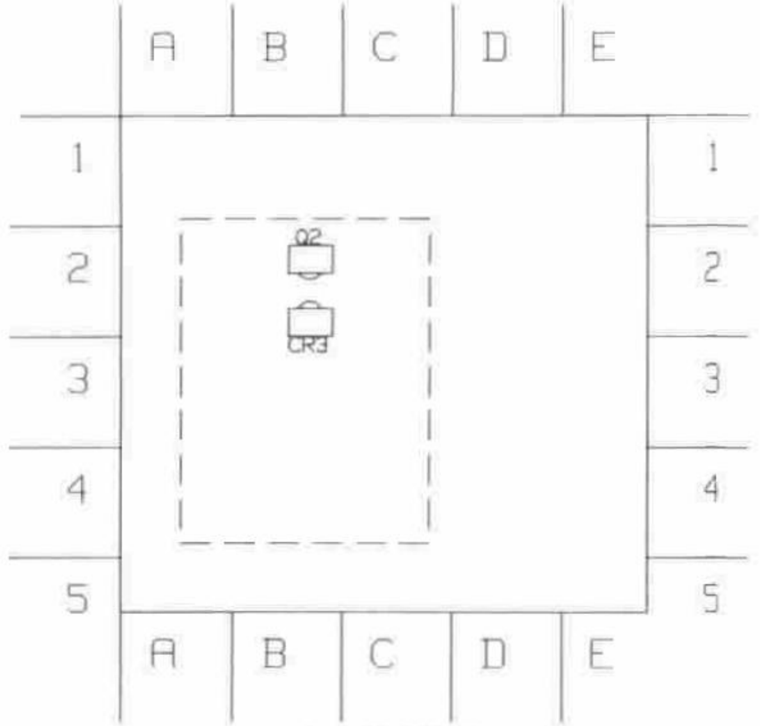
Reference Designator	Part Number	Qty	Description
C1	0180-3552	1	CAP-FIXED 4.7UF
C2	0160-5422	1	CAP .047UF 20%
CR1	1901-0620	1	DIO-SWITCHING
CR2	1901-0044	1	DIO-SWITCHING
CR3	1990-0906	1	PHOTODIODE
J41	1200-1445	1	SOCKET
J42	1252-0797	1	CONNECTOR
J43	1251-8106	1	CONN-POST-TP-HDR
J44	1251-8089	1	CONN-POST-TP-HDR
P4	43201-61603	1	CBL ASY-BATT/PCA
P45	43201-61607	1	CBL AY-RCDR PWR
Q1	1855-0582	1	MOSFET-N CHANNEL
Q2	1990-0905	1	PHOTOTRANSISTER
R1,6	0698-3441	2	RES 215 1% .125W
R2	0757-0465	1	RES-100K 1% .125
R3	0698-0084	1	RES-2.15K 1% .12
R4	0757-0280	1	RES-1K 1% .125W
R5	0698-8827	1	RESISTOR 1M
ZZ1	43201-86560	1	PCB-RAW
ZZ2	43201-84707	1	BAR CODE LABEL

REF DESIG	GRID LOC	PART NUMBER
C1	A3	0180-3552
C2	D3	0160-5422
CR1	B5	1901-0620
CR2	D3	1901-0044
J41	C2	1200-1445
P4	C1	43201-61603
J42	C3	1252-0797
J43	C4	1251-8106
J44	C5	1251-8089
P45	A4	43201-61607
Q1	B4	1855-0582
R1	D5	0698-3441
R2	D5	0757-0465
R3	D2	0698-0084
R4	D3	0757-0280
R5	D3	0698-8827
R6	D3	0698-3441
ZZ1	A5	43201-86560
ZZ2	A2	43201-84707


A
B
C
D
E
1
2
3
4
5
P4
ZZ2
J41
R3
R6
C2
R4
R5
CR2
J42
C1
RED
P45
BLACK
J43
Q1
ZZ1
CR1
J44
R2
R1

TOP SIDE

REF DESIG	GRID LOC	PART NUMBER
CR3	B3	1990-0906
Q2	B2	1990-0905


A
B
C
D
E
1
2
3
4
5
Q2
CR3

BOTTOM SIDE

PCB	43201-86560	ZZ1
BAR CODE LABEL	43201-84707	ZZ2

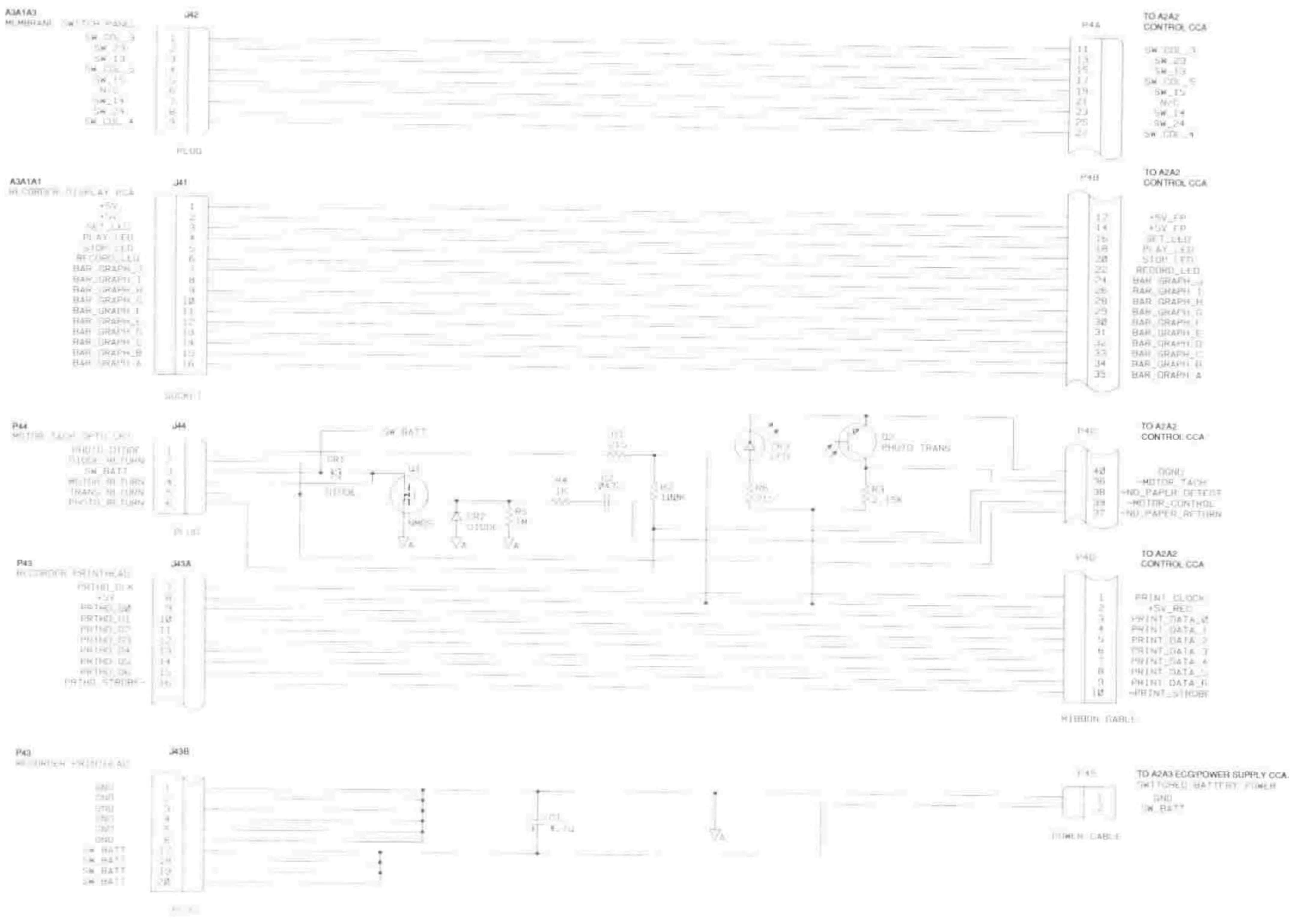

A3A1A3
MEMBRANE SWITCH PANEL
J42
SW_COL_3
SW_23
SW_13
SW_COL_5
SW_15
N/C
SW_14
SW_24
SW_COL_4
PLUG
P4A
TO A2A2
CONTROL CCA
A3A1A1
RECORDER DISPLAY PCA
J41
+5V
SET_LED
PLAY_LED
STOP_LED
RECORD_LED
BAR_GRAPH_J
BAR_GRAPH_I
BAR_GRAPH_H
BAR_GRAPH_G
BAR_GRAPH_F
BAR_GRAPH_E
BAR_GRAPH_D
BAR_GRAPH_C
BAR_GRAPH_B
BAR_GRAPH_A
SOCKET
P4B
+5V_FP
P44
MOTOR TACH OPTO CKT
J44
PHOTO DIODE
DIODE RETURN
SW_BATT
MOTOR RETURN
TRANS RETURN
PHOTO RETURN
PLUG
CR1
DIODE
Q1
NMOS
CR2
DIODE
R5
1M
R4
1K
C2
R1
R2
100K
CR3
LED
R6
Q2
PHOTO TRANS
R3
2.15K
P4C
DGND
-MOTOR_TACH
-NO_PAPER_DETECT
-MOTOR_CONTROL
-NO_PAPER_RETURN
P43
RECORDER PRINTHEAD
J43A
PRTHD_CLK
+5V
PRTHD_D0
PRTHD_D1
PRTHD_D2
PRTHD_D3
PRTHD_D4
PRTHD_D5
PRTHD_D6
PRTHD_STROBE-
P4D
PRINT_CLOCK
+5V_REC
PRINT_DATA_0
PRINT_DATA_1
PRINT_DATA_2
PRINT_DATA_3
PRINT_DATA_4
PRINT_DATA_5
PRINT_DATA_6
-PRINT_STROBE
RIBBON CABLE
J43B
GND
SW_BATT
C1
P45
TO A2A3 ECG/POWER SUPPLY CCA
SWITCHED BATTERY POWER
POWER CABLE

Figure 6-12. A3A1A2 Recorder Interface Circuit Card Assembly Component Locator and Schematic Diagram.

A3A1A2

43201-66530 A3A2 Monitor Control Display Circuit Card Assembly
See Figure 6-12 for Parts Breakdown

Reference Designator	Part Number	Qty	Description
C1	0160-5422	1	CAP .047UF 20%
C2	0180-3552	1	CAP-FIXED 4.7UF
C3	0160-3335	1	CAP 470PF 10%
CR1-12	1901-0044	12	DIO-SWITCHING
CR13	1902-0954	1	DIO-ZNR 6.8V 5%
CR14	1902-0783	1	DIO-ZNR 16V 5%
DS1-4,6	1990-1293	5	LED-LMP
DS5,7	1990-0958	2	LED-LMP
P10	1252-3022	1	CONNECTOR
P33	43201-61611	1	CBL ASY-CON DSPL
Q1	1855-0696	1	TRANSISTOR
R1-3,9-16	0757-0280	11	RES-1K 1% .125W
R4	0757-0462	1	RES-75K 1% .125W
R5,6	0757-0416	2	RES-.511K 1% .12
R7	0757-0394	1	RES-51.1 OHM 1%
R8	0757-0442	1	RES-10K 1% .125
SP1-7	0340-1220	7	SPACER-LED
U1	1820-3344	1	IC-MC74HC595N
ZZ1	43201-86530	1	PCBD-MON CONT/PL
ZZ2	43201-84703	1	LABEL-BAR CODE

REF DESIG	GRID LOC	PART NUMBER
C1	C2	0160-5422
C2	A2	0180-3552
C3	D4	0160-3335
CR1	B2	1901-0044
CR10	A3	1901-0044
CR11	A3	1901-0044
CR12	A3	1901-0044
CR13	C4	1902-0954
CR14	C4	1902-0783
CR2	B1	1901-0044
CR3	B1	1901-0044
CR4	C2	1901-0044
CR5	B1	1901-0044
CR6	B1	1901-0044
CR7	B3	1901-0044
CR8	B3	1901-0044
CR9	B4	1901-0044
DS1	D1	1990-1293
DS2	D2	1990-1293
DS3	D2	1990-1293
DS4	D3	1990-1293
DS5	B2	1990-0958
DS6	C4	1990-1293
DS7	D4	1990-0958
P10	B4	1252-3022
P33	A2	43201-61611

REF DESIG	GRID LOC	PART NUMBER
Q1	C4	1855-0696
R1	C2	0757-0280
R10	D4	0757-0280
R11	D1	0757-0280
R12	D2	0757-0280
R13	D3	0757-0280
R14	D3	0757-0280
R15	B3	0757-0280
R16	B3	0757-0280
R2	C2	0757-0280
R3	C2	0757-0280
R4	C4	0757-0462
R5	D4	0757-0416
R6	C4	0757-0416
R7	C4	0757-0394
R8	C1	0757-0442
R9	C1	0757-0280
SP1	D1	0340-1220
SP2	D2	0340-1220
SP3	D3	0340-1220
SP4	D3	0340-1220
SP5	B2	0340-1220
SP6	C4	0340-1220
SP7	D4	0340-1220
U1	C2	1820-3344
ZZ1	A1	43201-86530
ZZ2	D1	43201-84703

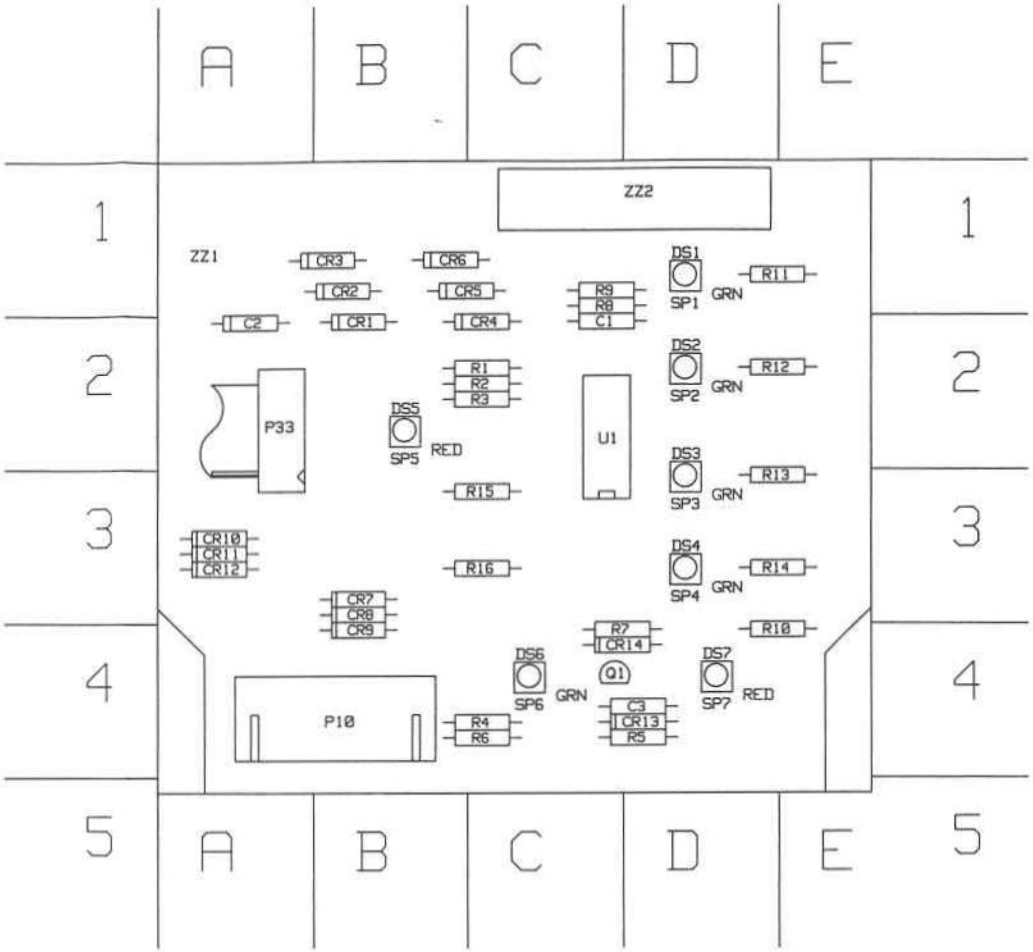

A
B
C
D
E
1
2
3
4
5
ZZ2
ZZ1
CR3
CR6
DS1
R11
CR2
CR5
R9
R8
C1
SP1
GRN
C2
CR1
CR4
DS2
R12
R1
R2
R3
SP2
GRN
P33
DS5
U1
SP5
RED
DS3
R13
R15
SP3
GRN
CR10
CR11
CR12
R16
DS4
R14
SP4
GRN
CR7
CR8
CR9
R7
CR14
R10
DS6
Q1
DS7
SP6
GRN
SP7
RED
P10
C3
CR13
R4
R6
R5
5
A
B
C
D
E
5

Figure 6-13. A3A2 Monitor Control Display Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 1 of 2).

PCB	43201-86530	ZZ1
BAR CODE LABEL	43201-84703	ZZ2
LED SPACER	0340-1220	SP1-7

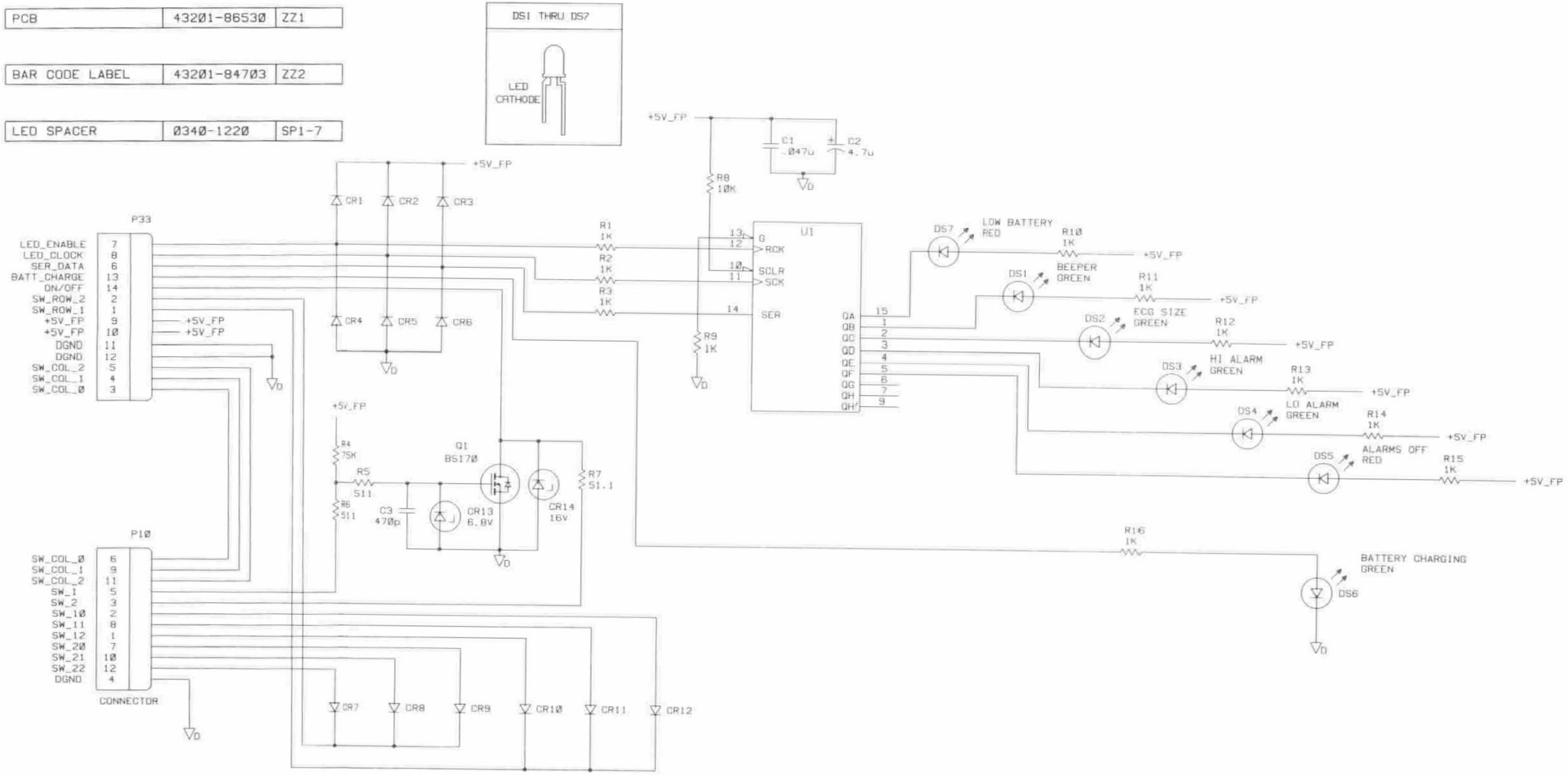
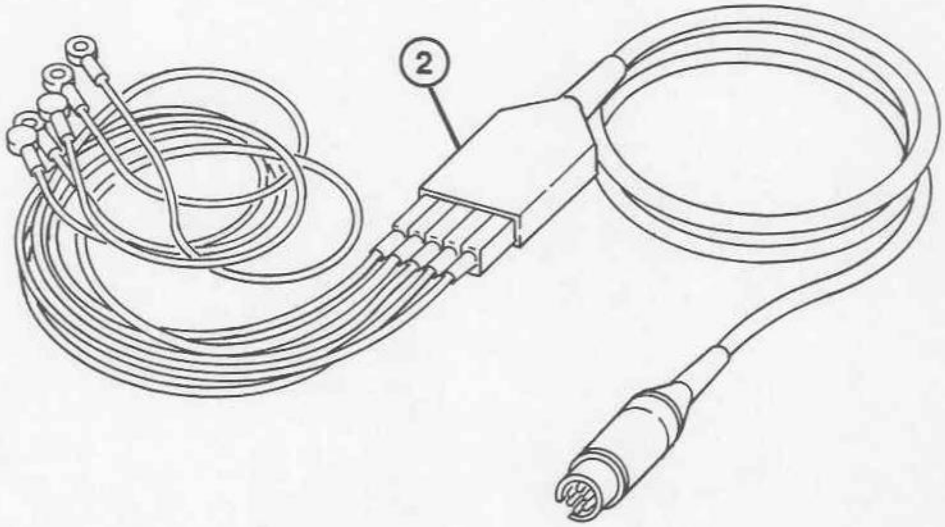
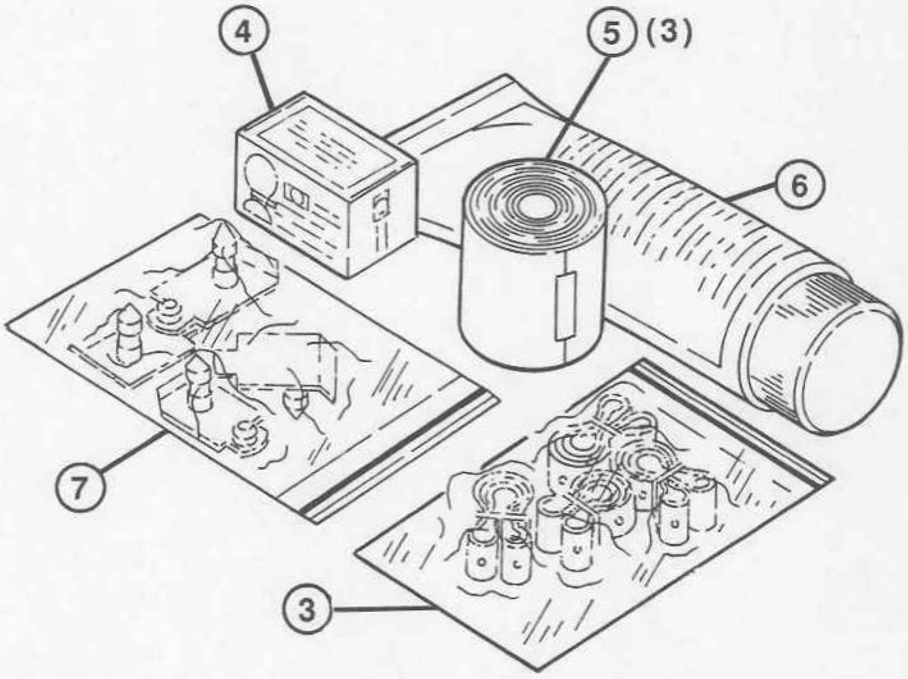

DS1 THRU DS7
LED
CATHODE
+5V_FP
C1
.047u
C2
4.7u
R8
10K
R9
1K
U1
G
RCK
SCLR
SCK
SER
QA
QB
QC
QD
QE
QF
QG
QH
QH'
13
12
10
11
14
15
1
2
3
4
5
6
7
9
R1
1K
R2
1K
R3
1K
CR1
CR2
CR3
CR4
CR5
CR6
P33
LED_ENABLE 7
LED_CLOCK 8
SER_DATA 6
BATT_CHARGE 13
ON/OFF 14
SW_ROW_2 2
SW_ROW_1 1
+5V_FP 9
+5V_FP 10
DGND 11
DGND 12
SW_COL_2 5
SW_COL_1 4
SW_COL_0 3
DS7
LOW BATTERY
RED
R10
1K
DS1
BEEPER
GREEN
R11
1K
DS2
ECG SIZE
GREEN
R12
1K
DS3
HI ALARM
GREEN
R13
1K
DS4
LO ALARM
GREEN
R14
1K
DS5
ALARMS OFF
RED
R15
1K
R4
75K
R5
511
R6
511
C3
470p
Q1
BS170
CR13
6.8V
CR14
16V
R7
51.1
R16
1K
BATTERY CHARGING
GREEN
DS6
P10
SW_COL_0 6
SW_COL_1 9
SW_COL_2 11
SW_1 5
SW_2 3
SW_10 2
SW_11 8
SW_12 1
SW_20 7
SW_21 10
SW_22 12
DGND 4
CONNECTOR
CR7
CR8
CR9
CR10
CR11
CR12

Figure 6-13. A3A2 Monitor Control Display Circuit Card Assembly Component Locator and Schematic Diagram (Sheet 2 of 2).

43201-87900 Accessory Kit

Reference Designator	Part Number	Qty	Description
1	1530-1239	1	ECG RULER
2	43201-61610	1	PATIENT CABLE
3	14030A	1	STRAP 15 (PK)
4	14324A	1	WELSH ELECTRODE
5	40453A	3	PAPER-THERMAL (RL)
6	651-1024-050	1	REDUX GEL 402
7	9301-1149	1	LIMB PLT. W/SNAP (PK)





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